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ULTRA-VIOLET LIGHT.

It is strikingly noticeable that the results of experimental investigations which are now being made public are apparently gradually but more conclusively indicating that Röntgen rays and light are one and the same phenomenon, the rays belonging to the ultra-violet end of the spectrum, and not the least important link added to the chain, should it be verified, would be that the rays have the power of producing the sensation of light on the retina. It remains however to demonstrate whether this action is one primarily due to fluorescence of the retina or any other part of the eye, or whether it be due to an action similar to that of ordinary light on the optic nerves. From the reports thus far obtained, it would seem that the crystalline lens is partly, if not perfectly, opaque to Röntgen rays, and it would be, therefore, due to this fact that their perception by the eye had not been previously discovered. Still stronger proof of the similarity of ultra-violet light and Röntgen rays is to be found in the demonstration that they not only obey the law of inverse squares, but that their velocity of propagation and that of light are one and the same. The fact that experiments seem to indicate that the rays are neither polarizable nor refractable, cannot be deemed as evidence sufficient to overbalance the conclusions based upon both of the above experiments, should both be in accord with the action of the light. The laws of inverse squares and the velocity of propagation certainly admit of experimental demonstration, although a simple and conclusive means of carrying out either is not perfectly evident. The measurement of the intensity of either weak or powerful illuminating sources, by photometric methods, is so unreliable that it is possible that the weak effects produced on the fluorescent screen, at various distances from the tube, could not be used as a demonstration of the former law, but even this method, owing to its simplicity, is certainly worthy of trial. A modification of one of the several methods used for the determination of the velocity of light could possibly be made available.

VACUUM TUBE LIGHTING.

An opportunity was given at the general meeting of the Institute last week to discuss the paper previously presented on vacuum tube lighting. We print in this issue, as fully as space will permit, the opinions of several of the members who took part in the discussion, and which, considered as a whole, was more favorable to Mr. Moore than was at first thought possible. This fact was largely due to the figures presented representing a test of the energy supplied to the tubes. Those given in another column, although obtained by an unrefined and approximate method, are still sufficiently accurate to demonstrate that the tubes as displayed at the Institute meeting were operating under unfavorable conditions and that the energy required to excite the 27 then employed was in the neighborhood of two horse-power, and not ten horse-power, as many were led to believe at that time, judgment being based upon the action of the machines. Probably a more accurate and decisive method of determining the energy required would be to use a motor dynamo, and when all the tubes are operating at their best to measure the input, then by substituting for the tube load a bank of lamps such that the output required the same input previously recorded, the elimination of the more variable factors would thus be obtained. The measurement of the power absorbed, however, is of little importance if the illuminat-

ing effect is not at the same time considered. Definite measurements as to the quantity of useful light produced are entirely wanting, and owing to the greater actinic effect in light, such as that emitted by the Geissler tube, photographic results used as the bases for estimating the effective illumination are practically valueless. As to the system itself, it differs from others hitherto employed in the very simple and effective means used to excite the tubes, and it is for this reason that Mr. Moore has made considerable advancement in the art for which he deserves credit, but not for having produced a new light. Whether or not vacuum tubes as at present constructed have a commercial field of usefulness for purposes of illumination, remains to be seen. It does not necessarily follow that because a system is more expensive in its operation than previous systems that it is not likely to come into general use. It is an historical fact that the systems of electrical illumination now in vogue have come into prominence not because they are cheaper than the candle, oil or gas light, but because of the growing tendency of civilization to demand increased comforts rather than a decrease in the cost of obtaining them. This tendency may show itself in the case of vacuum-tube lighting, but until considerable improvement has been made in the quality of light emitted from such tubes as those with which we are at present familiar, this form of illumination is not likely soon to create for itself a very extensive field of commercial application.

THE INSTITUTE PAPERS.

The papers presented last week before the American Institute of Electrical Engineers, although few in number as compared with previous general meetings, were of sufficient importance in their scope to provoke considerable discussion. The extensive preliminary report of the sub-committee on standards of light was well received by those present, and the committee deserves much credit for the thorough manner in which it has carried on the investigations thus far pursued. There seems to be, however, no very good prospect of obtaining any great improvement in the methods of photometric tests at present employed, but we trust that the efforts of the committee will furnish at least a more exact and scientific method of determining what has proved up to the present to be one of the most unreliable of physical measurements. The paper on transformer curves by Mr. Huguet is, theoretically considered, an excellent contribution, and one which materially clears up a question hitherto involved in considerable obscurity. The explanations offered in the discussion on the similarity of the effects of variable permeability and hysteresis do not seem warranted; in fact, Prof. Ewing pointed out as early as 1893, that there exists in iron a distinct difference in its hysteretic and permeable qualities. Another point upon which Mr. Huguet lays particular stress is that hysteresis may in all respects be replaced by a constant resistance if the hysteretic characteristic be a quadrant of an ellipse. He shows that the conclusions drawn by Prof. Rowland, to the effect that the harmonics in the transformer are due to the variation in permeability, and not hysteresis, is approximately correct, and may be absolutely so under certain conditions. The point was, however, raised that this conclusion, although applicable to the open-cored type, would probably not hold true in the absolutely closed ferro-magnetic circuit, owing to the fact that the molecular action of the iron proves to be decidedly different from that in the former type. As stated by Mr. Steinmetz, the paper is one which is not likely to be lost sight of within a year or two. The paper on the "Effect of Temperature on Insulating Materials" proved exceedingly interesting, and provoked considerable discussion. The subject is one of great commercial importance, and for this reason the method of testing employed deserves careful attention. The paper, although treating of temperature beyond the scope of good commercial apparatus, indicates the factor of safety which must be used in design of apparatus employing such materials as were experimented upon. The chief information to be derived from the tests seems to be the fact that plain paper is better than insulating varnishes as far as temperature is concerned. In dynamo machines, however, the insulation has to withstand mechanical stresses and the destructive effect of continuous vibration, which slowly diminish the insulation resistance of the materials employed, and gradually change the electrical conditions so that the tendency is for more heat to be generated. Thus a bad spot in the armature insulation may spread with surprising rapidity until the whole has become practically worthless. It would have been better, therefore, if the tests that were made had conformed more nearly to the actual working conditions under which the insulation is subjected. In the lamination of iron the method suggested by Mr. Scott conforms more nearly with actual practice, but for an exact determination of purely insulating qualities, the method adopted by the authors appears to be better, owing to the fact that the escape of moisture is more readily permitted. If the insulation tests could be carried out upon a revolving armature or in apparatus for which the insulation is to be used, more exact conditions would be obtained, and for this reason the tests would be made more valuable. The phenomenon noticed that when after the temperature has risen above 100 degrees C., the zinc in the brass cylinder combines with the copper wire wrapped about the insulation, and in turn the cylinder becomes coated with a copper surface, is one which deserves careful consideration. Prof. Crocker doubtless explained the phenomenon by considering that the volatilization of the two metals could probably take place at even this low temperature. The experimental study of E. M. F. induced on breaking a circuit shows conclusively the dependence which may be placed upon the phenomena which theory calls for. The method used for determining the curves of discharge is for its sensitiveness certainly remarkable. The paper on the production of electrical energy in office buildings, though applied to the methods used in one particular case only, is in the details of the construction certainly worthy of careful study, and in several points indicates a radical departure from methods to be found in isolated installations. The publication of the results of the operation of this plant should doubtless prove of value to those interested in this branch of construction and will be looked forward to with considerable interest.

International Congress of Electricians at Geneva.

In connection with the Swiss National Exposition, the Swiss Society of Electricians have invited other societies to participate in an international congress of electricians during the month of August. The congress will continue for four days, the mornings being devoted to discussions and the afternoons to visiting various points of interest. The questions to be discussed are as follows:

First: The magnetic units and their denomination.

Second: The photometric units and their denomination.

Third: Long-distance transmission of power by both continuous and alternating currents.

Fourth: Protection of high-tension lines against atmospheric discharges.

Fifth: Various troubles encountered in electric railway operation.

The American Institute of Electrical Engineers has not, up to the present time, received official invitation to send a representative to the congress, but as Mr. C. S. Bradley expects to visit Europe at that time, it was suggested that he might attend the meeting as an unofficial representative of the American body. The Congress does not seem to be attracting any particular attention on this side of the Atlantic.

A Twenty-Seven Year United States Telephone Patent.

BY E. F. FROST.

By statute the period for which a United States patent for an invention is granted is limited to 17 years from the date of its issue to the patentee. This period cannot be extended by any means, even a reissue expiring on the expiration of the original patent.

Yet it is possible that the statute which limits the life of a patent to 17 years may be subverted to such an extent as that a patent originally granted for the period of 17 years shall be practically secured to the assignee of the inventor for 27 years.

In order to show how this may be brought about, let us review the following facts:

On June 4, 1877, Mr. Emile Berliner applied for letters-patent for an invention which were issued in 1891, and which has now become the notorious microphone patent.

In 1881 Mr. Francis Blake secured letters-patent for a microphonic transmitter.

Both of these patents became the property of the American Bell Telephone Company.

By reason of the expiration of foreign patents for the same invention the Blake United States patents have expired and therefore, according to the spirit and letter of the law, have become public property.

The Berliner patent, now the subject of litigation, if held valid, will expire in 1908.

The Berliner patent, however, is inclusive of the Blake patent, in that constant contact between electrodes, claimed as the invention in the former patent, is employed in and is essential to the latter.

Let us suppose the Berliner patent to be held valid in its broadest interpretation; then the Blake patent can be held to be an infringement of the former in so far as it employs constant contact between electrodes, the feature essential to its operation.

Therefore the American Bell Telephone Company will be in a position to say that the public shall not enjoy this Blake patent which has become public property, except it be emasculated of that which is vital to its working.

Not only this, but the American Bell Telephone Company, by virtue of its ownership of the Berliner patent, secures to itself the sole power to use the Blake patents in their unemasculated condition until the time of expiration of the Berliner patent in 1908.

This virtually secures to the Bell Company the sole control of the Blake microphone patents for the period extending from 1881 to 1908, a period of 27 years, or for 10 years more than the maximum period for which a United States patent is granted.

It is in order to ask whether the Bell Company shall be subject to the same conditions and restraints as may be imposed on others: or, shall it be granted privileges which others shall not be able to secure in equal right?

Will the courts, if they uphold the validity of the Berliner patent, enjoin the Bell Company from using the Blake patents or any other patents which have become public property, and which infringe the Berliner patent?

In other words, will the courts place on the Bell Company the same conditions and restraints with regard to public property that it will place on the public itself?

Such restraint might not be "good law," but it would be "good sense" and justice. Moreover, it would, if not according with the letter of the law, at least be in accord with the spirit of the law.

From every side on which the Berliner patent is approached there results, if it be held valid, subversion of the law, discrimination against the rights of the public in public property, discrimination against the rights of individuals and the public in individual property, discrimination in favor of the Bell Company in that the law is to be interpreted as obtaining for an individual, the Bell Company, and not for all individuals, the public; that is, the law is made for the one and not for the many, and there results injustice.

Moreover, the upholding of the validity of the Berliner patent will involve the interpretation of the patent law in every conceivable anomaly as to the status of every patent grant issued thereunder; also as regards the status of individual and public rights in patent property created thereon.

While the motives which seek the upholding of the Berliner patent are no doubt those interests which strive by legal methods to protect themselves in rightful property, lest otherwise they might become wrongfully abridged, yet have not the enjoyment of monopoly and the powers and the rich harvests therefrom blinded those interests to the fact that the very rights which they seek are those which they have already enjoyed, so far as contemplated by the spirit and intent of the law? Are not those interests blind to the fact that their attempt is in reality a deliberate conspiracy to legally secure the cooperation of courts of justice to work injustice by the subversion of the law?

A Test on Vacuum-Tube Lighting.

The following is a report of a test of the power absorbed by the vacuum-tube light as exhibited by Mr. Moore, at the Electrical Exposition, made by Prof. W. A. Anthony, Prof. E. L. Nichols and Mr. Nelson W. Perry.

"A Weston ammeter was placed in the circuit leading to the motor used for driving the generator which furnished the current for the vacuum tubes, and a Weston voltmeter was placed across the motor terminals. These instruments were read at frequent intervals, while one of us in the booth below noted the time of turning on and off the light. Comparing notes we found that when the tubes were all off, the motor consumed 12.5 to 13 amperes at 110 volts as a constant load. When the tubes were all on, the motor consumed 22 amperes at 108.5 volts. The motor therefore consumed, when tubes were not running, 1402 watts; when the tubes were all running, 2387 watts; due to tubes, 985 watts.

"There were in operation 14 tubes, each 7½ feet long and 1¼ inches in diameter, one tube somewhat shorter but 2½ inches in diameter, and a few tubes of special designs.

"We estimated that the whole was an equivalent of 16 of the 1¼ inch tubes. This gives 61.6 watts per tube applied to the motor terminals. Assuming that 8 per cent. of this energy was delivered to the tubes from the generator terminals, the power consumed by each tube would be 49.28 watts.

"This is practically the result obtained by Mr. Wetzler by direct measurement of the energy consumed by the tubes, and disposes of the question raised by the writer as to the reliance to be placed upon the indications of a Weston ammeter in circuit with a vibrating interrupter.

"The only question now is as to the intensity of the light obtained. Of this it was impossible, under the conditions, to make any reliable estimate. Our results simply show that the light of the vacuum tubes as exhibited in the booth at the Exposition is obtained at the expense of a little more than one horse-power.

"The instruments used in making these measurements were kindly loaned for the purpose by Mr. Pronnie, in charge of the Weston Electrical Instrument Company's exhibit, who gave us his assistance in making the necessary connections and in taking readings.

Exposition of the International Society of Electricians.

The Exposition of the International Society of Electricians was held in Paris during the 2d, 3d and 4th of May, 1896. The exhibits included a display of electrical cooking utensils, illustrating their practical applications, medical apparatus and static machines, Röntgen rays and fluorescent tubes, measuring instruments, new models of induction coils, storage batteries, continuous and polyphase generators and motors, etc. The Exposition attracted a great number of visitors, and above all it demonstrated that electricity can be utilized in a vast variety of simple and effective ways. All the apparatus was shown in operation and the illuminating effects were exceedingly fine."

Röntgen Rays to Accompany the Nile Expedition.

So thoroughly practical are Röntgen rays considered by the Medical Department of the War Office of the British Government that two sets of Röntgen ray apparatus have been ordered sent up the Nile to be used by the army surgeons in locating bullets in soldiers and to determine the extent of bone fractures.

Discontinuing Patent Suits.

It is stated that arrangements have been made under the agreement recently effected between the General Electric Company and the Westinghouse Electric & Manufacturing Company to discontinue about 300 patent suits pending between the two companies. Apparatus purchased from either one of these companies is delivered to customers, it is stated, with a guarantee against suits.

A New Method for Testing Lubricants.

BY PAUL MAC GAHAN.

During the course of an investigation made in the mechanical laboratory of Columbia University by Mr. George Heye and the writer on the various lubricants used for electrical machinery, some original and useful results were obtained by means of what we believe to be a new method.

At first the Thurston method of testing for the coefficient of friction was employed, using the well-known Thurston oil tester, consisting of a revolving shaft supported on two bearings, and driven by a pulley between them. At the front end of the shaft is a tube of hardened steel about three-eighths of an inch thick and one and five-sixteenths of an inch in diameter which fits over it, being coupled to a bushing by means of steel dowel pins, forcing the sleeve to rotate with the shaft. This sleeve, or tube, forms the bearing used for testing the lubricant, and revolves within a bronze journal box. The oil is introduced by means of a cavity in the top brass which is closed when in action by the base of a thermometer mounted in brass. To the journal box is suspended a known weight at the end of a pendulum 10 inches long.

The journal is in two parts, and the pressure on the shaft is regulated by a nut-and-spring arrangement, which presses the brasses together with a force the value of which in pounds may be read off from a vertical scale, as in a spring balance.

When the shaft revolves the frictional force deflects the pendulum from the perpendicular, and the deflection reduced to pounds corresponding thereto is read from a circular scale fastened to the frame of the tester.

The coefficient of friction is the friction reading divided by the pressure on the bearing.

This arrangement forms a very satisfactory method of testing oils, but very few power houses are supplied with such an oil tester, and have to rely on the general experience acquired by using the oils in

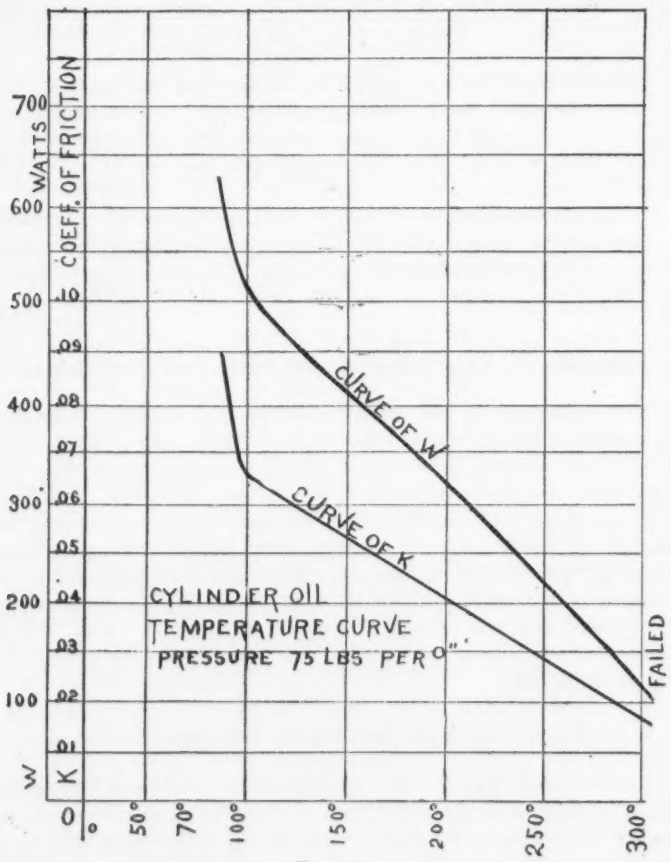


Fig. 1.

their machinery, having no satisfactory way to judge of their qualities prior to purchasing.

The whole oil tester can be dispensed with, however, where electric power is at hand by using the following method:

A simple bearing is rigged upon a shaft, consisting of a sleeve turned to a close fit and keyed to the same, two bronze or babbitt metal brasses forming the journal, so arranged that a known weight can be applied to them, provision being made for introducing the oil or other lubricant.

The shaft is driven by a small shunt-wound electric motor, whose speed can be regulated by means of a water barrel in the armature circuit, and a rheostat in the field. By this means the speed can be controlled within 1 per cent. and kept constant.

The speed of the rubbing surfaces in the journal should approximate to that used in the machinery, which the oil is to finally lubricate.

The power supplied to the motor is observed by means of a wattmeter. The watts required, when there is no pressure on the bear-

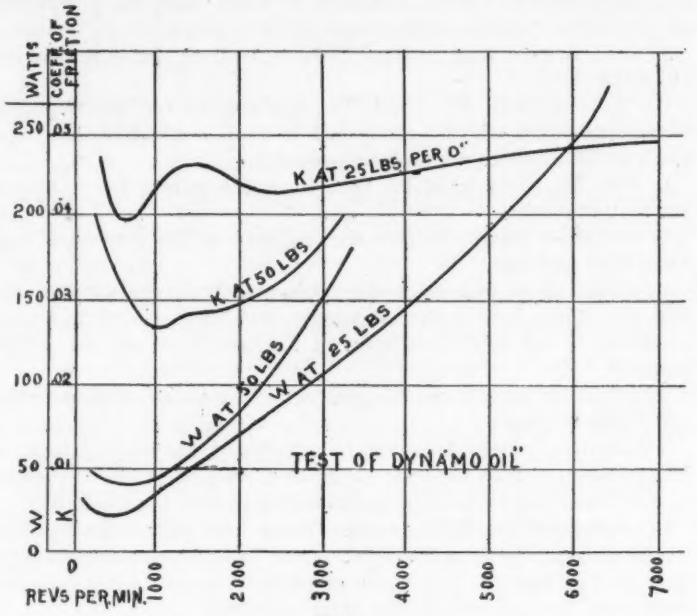


Fig. 2.

ing, are subtracted from the watts used when the pressure is put on, which gives the watts dissipated in the bearing by friction.

From the watts used, the speed of rubbing surfaces and the pressure, the coefficient of friction can be determined very accurately. For we have:

$$W = \frac{F \times S}{44.2}$$

where W represents the watts consumed, F the friction in pounds, S the speed of the rubbing surfaces, in feet, per minute, and 44.2 the foot pounds per watt expended, whence:

$$F = \frac{W \times 44.2}{S} \quad \text{or} \quad K = \frac{F}{P} = \frac{W \times 44.2}{PS}$$

where P is the total pressure on the bearing and K the efficient of friction.

A suitable bearing can be made at a trifling cost, and if no wattmeter is at hand, a voltmeter across the motor's terminals, and an ammeter in series with it, by simultaneous readings will give the watts. These instruments are generally at hand in electric power houses.

Besides the coefficient of friction results obtained in the ordinary manner with a Thurston oil tester, some interesting watt-curves were produced, showing the watts consumed in each oil at various speeds up to 6000 revolutions, giving a greater speed of rubbing surfaces than is ever likely to be met with in dynamos. Curves were also obtained showing the watts dissipated at various temperatures, the speed being kept constant at 3000 revolutions. Cylinder oils were tested to over 300° Fahr. The curves shown in Figs. 1 and 2 give several of the results obtained.

Some of the general conclusions arrived at during these tests are:

First: The coefficient of friction varies inversely as the temperature. It may be expressed by means of this relation:

$$K = k' (1 - nt^\circ)$$

where k' is the coefficient of friction at some initial temperature, say 80°, t° = the increase in temperature, and n = a constant, different for each kind of oil; n was found to vary between .006 and .0035, according to the oil used. This formula is very nearly correct between 90° and the temperature at which the oil begins to deteriorate.

Second: The coefficient of friction increases with the speed, after the "static" friction has been overcome. This is not at once evident from a glance at the curves obtained, but when the effect of temperature is taken into consideration, which would tend to decrease

the value of the coefficient, it is evidently so. It was found impossible to keep the temperature of the bearing constant, but a correction for temperature was made by using the formula given above.

Third: At slow speeds the watts consumed seem to be directly proportional to the pressure.

Some Experiments with Röntgen Rays.

BY W. C. PECKHAM.

A series of experiments performed on April 13 with Röntgen rays may be of interest to other experimenters. The vacuum tube used is of German make, pear-shape and 12 inches long. It gives little fluorescence, and often, when most active, the cathode cone can scarcely be seen. It was enclosed for the purpose of these experiments in a light-tight box, and was in a room built for photometric work, painted within a dull black.

Experiment 1.—A barium-platino-cyanide screen placed against the end of the box opposite the cathode glowed brightly, and by moving it about the area of Röntgen rays is easily explored, and with experience a rough estimate can be made of the proper time for exposure.

Experiment 2.—To test the idea held by some that the photographic action may be due to the fluorescence of the film, I held an unexposed plate where the screen had shown the rays to be strongest. Its fluorescence was quite marked, but was stronger when the sensitive film was on the side of the glass furthest from the tube. This suggested a test of a photographic film. It gave no fluorescence.

Experiment 3.—To confirm the probability that the glow in Experiment 2 was produced by the glass, a clean plate of glass was tried. It became luminescent. Next, a piece of heavy plate glass five-sixteenths of an inch thick was used, and the fluorescence was much stronger. A second similar plate, however, did not increase the effect.

Eyeglasses placed against the end of the box shone like two ghostly eyes staring from the dark. A porcelain evaporating dish in the same position glowed like a hemisphere with milky light.

Experiment 4.—A jar of water in which uranite was dissolved, held near the box, showed marked green fluorescence by reflection from its side, and particularly from its rounded corners. This was a battery jar of very thick glass, through which the rays must have passed to excite the fluorescence of the material within it. Glass has been held to be opaque to the rays, unless very thin.

Experiment 5.—I have a set of spectrum tubes (so called). It consists of seven tubes in a small wooden box, purchased in 1882, and which after exposure to sunlight phosphoresces for some time with hues closely resembling those of the spectrum. They presumably contain calcium sulphide and are sealed by fusing the end of the tube. When these tubes are subjected to Röntgen rays they glow nearly as brightly as under the action of the sun. I have several times read the time on my watch by their light in Röntgen rays, and have also made an exposure of a photographic plate by the same light, and developed it in the ordinary way.

It would seem that the rays ought also to be convertible into heat, but thus far I have not been able with the thermopile to detect them.

Experiment 6.—It was noticed when holding the eyeglasses against the end of the box that the rims were in some positions luminous, and on trying these more carefully a star of light was seen on their points.

My object in making these experiments was to dispense with the fluoroscope and its use by individuals one at a time; to turn my lecture room, with the audience in it, into a large fluoroscope, if I may so term it, and to show the effects to all at once. This was accomplished with entire success on April 18, and again before the Brooklyn Institute on April 28. People sitting across a hall seating 1000 people saw the fluorescence through 10 inches of pine boards, as also the bones of the hand when it was held behind the fluorescent screen. It would seem as if the strong, oscillating electrostatic action on the outside of the tube is concerned in the production of this very singular series of effects. These oscillations are certainly synchronous with the vibrations of the cathode rays in the tube, which in turn synchronize with the oscillations in the induction coil. If the vibrations of the tube cannot keep time with those of its coil, few or no Röntgen rays will be given out. The case seems to me to be similar to that of sympathetic vibrations in sound. In a word, the Crookes tube is a resonator for its coil, and when coil and tube are properly attuned the maximum effect is obtained.

Annual Meeting of the American Institute of Electrical Engineers.

The annual and general meetings of the American Institute of Electrical Engineers were held at the New York Industrial Building on May 19 and 20.

At the business meeting at 4 p. m. on May 19, the reports of Council and the treasurer were presented, and the ballots for the election of officers counted.

The report of Council for the year ending April 30, 1896, shows that 10 regular meetings and one special meeting were held during the year. Reference is made to the incorporation of the Institute on March 16, 1896, under the laws of the State of New York; also to the representation of the Institute by Prof. F. B. Crocker, at the National Conference on Standard Electrical Rules, held on March 18 and 19 last. Prof. Crocker will continue to serve as delegate for one year.

The total membership of the Institute at the close of the year was 1035, a net gain of 91 during the year.

The secretary's report gives an itemized statement of receipts and expenses during the fiscal year.

The treasurer's report shows receipts from the Secretary for the year ending May 1, 1896, $11,262.90; payments, $11,209.19.

The building fund amounts to $939.48.

At the general meeting on May 20 the result of the ballotting for officers for the ensuing year was announced as follows:

President, Dr. Louis Duncan, of Baltimore; vice-presidents, C. P. Steinmetz, Schenectady; Prof. Harris J. Ryan, Ithaca, and Prof. W. M. Stine, of Chicago; managers, L. B. Stillwell, Pittsburg; John W. Lieb, Jr., New York City; F. A. Pickernell, New York City, and Prof. William L. Puffer, Boston; treasurer, George A. Hamilton; secretary, Ralph W. Pope of New York City.

This was the council ticket.

Standards of Light.*

BY EDWARD L. NICHOLS, CLAYTON H. SHARP, AND CHARLES P. MATTHEWS.

One of the sub-committees appointed in 1893 to investigate the subject of a suitable standard of light for photometric purposes has been engaged upon preliminary experiments, and upon the collection of data concerning the existing standards, and also of such other sources of light as might be regarded as possible substitutes for the standards now in use. Such investigation is a necessary preparation for the consideration of recommendations looking to the adoption of any new standard.

The following sources of light have been in use in photometric work for a sufficient length of time to enable various observers to become acquainted with their merits and likewise with their imperfections.

(1) The Carcel Lamp.
(2) The British Standard Candle.
(3) The German Standard Candle (Vereinskerze).
(4) The Methven Screen.
(5) The Hefner-Alteneck Amyl-acetate Lamp.
(6) The Harcourt Pentane Standard.
(7) The Harcourt Pentane Lamp.

In addition to these, the Violle platinum standard of light has been before the scientific public for several years, and although it has not gone into extensive practical use, it has been subjected to severe tests in the laboratory of the German Imperial Institute for Research (Reichsanstalt in Charlottenburg) and elsewhere. Various luminous gas flames, also incandescent lamps, have been extensively used as secondary standards. The following standards have likewise been proposed, and a certain amount of work has been done to demonstrate their good properties and to determine the degree of accuracy with which they can be reproduced.

(1) The crater of the positive carbon in the arc.

(2) The surface of a strip of platinum heated by means of a current to an arbitrarily defined temperature.

Finally there are a number of light sources which must be taken into account in the selection of a standard of light, aside from those which have been mentioned in the above list. Such are gas flames burning within a mantle of pure oxygen (the Bude Light), the

* Abstract of preliminary report of the Sub-Committee of the American Institute of Electrical Engineers presented at the general meeting, New York, May 20, 1896.

acetylene flame, the various incandescent mantle burners, the light from other glowing metallic oxides, such as the zircon light and the light of burning magnesium.

The committee proposes to present in this report a summary of measurements which have been made upon the various sources of light mentioned above, with a view to reaching some decision with reference to their relative merits as light standards. It is hoped thus to pave the way for experiments leading to the recommendation of new definitions of the standard of light, or at least to the recommendation of greatly improved procedure in the handling of existing standards.

In the case of many of these sources of light, the members of the committee have made extensive measurements of their own, either in the verification of existing statements, or in the exploration of questions hitherto not definitely attacked. It is proposed in this report to give a brief *résumé* of these experiments, some of the results of which have already appeared elsewhere, and to summarize the existing work of previous investigators, so far as the committee is acquainted with the same.

Tests of standards of light belong to one of two general classes ; in the first class are included all comparisons of flames with flames, the results of the tests being in this case affected by the change of the standard flame with the purity, temperature, and hygrometric state of the atmosphere. They show in general only the variations of the standard in question which take place during short periods of time, and demonstrate nothing concerning the variations which take place from day to day. In the second class are included all comparisons of light standards with glow lamps and also bolometer tests.

The committee concludes from a summary of previous photometric researches and from the report of its own work, that of all standards thus far used, candles are the least reliable.

That it seems likely that many of the difficulties which are unavoidable with flame standards may be overcome by the adoption of a standard consisting of some surface electrically heated to a standard temperature.

That the definition of the degree of incandescence of such a surface appears at the present to present almost insuperable difficulties, but the committee is at work upon a method for the measurement of the temperature of incandescent carbon, which may lead to results looking toward a solution of the problem.

It also has in progress experiments looking to the production of a light standard in which not only the burning material, but also the atmosphere shall be of known and definite chemical composition. Liebenthal's experiments indicate clearly that this is a necessary condition to the production of any invariable flame. In the preliminary experiments now under way, a flame of a mixture of two parts acetylene to one part hydrogen, burns in a current of pure oxygen, all the gases being dry. The flame produced by these means is of dazzling brilliancy, its color being comparable to that of the lime light. No accurate measurements of its steadiness or reproducibility have yet been made.

This experiment will include a spectro-photometric study as well as an investigation of the range of fluctuation to which it is subject under different conditions of combustion.

DISCUSSION.

Dr. Nichols stated that the only form of amyl-acetate lamp which the committee has tried is the standard form furnished, and the great difficulty which seems to exist with that lamp is the redness of the flame. It has been shown by the very painstaking investigations of certain German students on this subject that the atmospheric conditions, unless artificially controlled, are sufficient to produce a definite fluctuation in those standards. For example, the amyl acetate lamp has been tried for two or three years, and it has been shown to vary with the time of year, giving more light in certain months than in others, and these curves of fluctuation, occurring with the meteorological forces, with reference to the amount of moisture in the atmosphere during those times, are such that it seems we must abandon the open air as a source of supply for such flames, and introduce instead of it the artificial supply.

A Good Suggestion.

An English contemporary, in referring to the recent death in Munich of Prof. Geffcken through the explosion of a lamp, states that "safety rules" should be enforced in using this dangerous agent of death and destruction.

The Paris Electrical Exposition of 1881.

BY WILLIAM J. HAMMER.

Expositions, particularly those of an international character, exert influences of tremendous scope and power, and among the most potent, aside from the purely commercial factors in their inauguration and consummation, are: First, the stimulus given to scientific research and invention, and second, the bringing before the public of much that is meritorious and much that would have otherwise laid for a time, at least, in obscurity.

Contemporaneous with many of the great expositions of the past may be mentioned the bringing forward of an epoch-making discovery or experiment in electrical progress. Witness Fontaine's historic experiment with the Gramme machines, at the Vienna Exposition in 1873, demonstrating the reversibility of the dynamo. Again, the birth of the Bell telephone, at the Centennial Exposition at Philadelphia, in 1876. The powerful impetus in the development of the electric light, given by the Paris Exposition of 1878, and to those privileged individuals who attended the first electrical exposition of the world, held at Paris, from Aug. 4 to Nov. 20, 1881, it marked a stupendous advance in practically all branches of electrical development.

Here Edison, Swan and Maxim invited the world to behold the commercial incandescent electric light, a problem solved by thousands of incandescing filaments of carbon, hermetically sealed in receptacles of glass, and here Edison showed not merely his incandescent lamps, but a complete system of electric lighting, with his dynamos, switches, regulating devices, apparatus for indicating volume and pressure of the electrical current, a meter for measuring the amount of current supplied to consumers, electric motors for supplying power and a complete system of underground conductors with feeders, mains, safety fuses, junction boxes, etc., the whole forming what was doubtless the most important feature of the Paris Exposition, and with the splendid exhibit of his inventions in telegraphy, telephony, the phonograph and many other features challenging the admiration of all who visited the Exposition.

Here Werner Siemens carried on his electric railway 100,000 people from the Champs Elysees to the Exposition in the Palais de l'Industrie, and, I believe, without injury to a single individual. Current was supplied by a traveling contact attached by a flexible cable to the car, the contact sliding along in a brass tube slotted at the bottom and supported partly by a bracket fastened to an iron pole at the street curb (which also carried the return circuit), and partly by sheet iron straps hanging from a galvanized iron wire, supported from above by a second bracket on the pole. There was also a Gramme motor, used to drive a locomotive alongside the Palais de l'Industrie, friction gearing being employed. This was, however, merely as an exhibit and not for transporting the public.

Edison showed to the world his giant "Jumbo" dynamo, weighing 22 tons, the forerunner of all the great direct-connected dynamos of to-day, the tardy arrival of which had caused so many doubting Thomases to shake their heads when they looked at the huge empty foundation, but who showed their undisguised admiration and surprise when the machine ran with its 1,000 lights. Here were the rooms crowded with people listening to the entrancing music from the far away grand opera through the Ader and Gower-Bell telephones. Here Marcel Deprez showed his interesting system of power transmission, consisting of a Gramme dynamo driven by a gas engine, its field excited by a small Siemens dynamo, and supplying electricity to Deprez motors driving 27 machines and tools, such as sewing machines, metal and wood cutting machines, plating machines, lathes, drills, printing presses, and supplying from the same source an arc lamp, an incandescent lamp and power to drive a dynamo. The Gramme Company also exhibited an engineer's workshop driven by a Gramme motor with lathes, planer, punching, drilling and shearing machines in operation.

The Paris Exposition was notable by reason of the many electric lighting systems shown there for the first time, and because it was the first exposition to be lighted entirely by electricity.

Among the continuous and alternating types of dynamos shown for arc and incandescent lighting, electric power, electro-deposition, etc., may be mentioned those of Gramme, Siemens, Edison, Brush, Maxim, Lontin, Crompton-Burgin, Gülcher, Jablochkoff, De Mertens, Weston, Seeley and Tebbuts (Arago Disc) Lechaussee, Wilde, Alliance, Born, Noglo, Delaye, Gravier, Shuckert, Hafner-Alteneck, and Jurgensen and Lorenze.

Many types of arc lamps were shown, among them being the Brush, Maxim, Weston, Jasper, La Soliel, Siemens, Ball, Serrin, Delaye, De Mersaune, Solignac, Chertemps, Dubosc, Crompton,

Naglo, Pilsen, Joel, Shuckert, Regnier and Rapieff. The semi-incandescent arcs at that time attracted considerable attention, particularly the Werderman lamps, and the candle form of arc lamps formed a notable group, comprising the Jablochkoff, Jamin, Wilde, Debrun, Andrews and Delaurier. By the side of the powerful dynamos, at the Palais de l'Industrie, in 1881, and forming a most interesting comparison to these magnificent products of the most recently acquired knowledge and skill in electrical and mechanical design, might be seen those most precious relics of the early pioneers in electrical discovery. There, for instance, stood the original apparatus of Oersted, of Ampere, of Arago, and of Faraday, and side by side with the simple apparatus by which Faraday demonstrated the first electric current obtained by induction from a magnetic field, stood the original magneto-electric machine of Pixii of Paris, and that wonderful machine invented by Dr. Antonio Pacinnotti, Professor of Physics, in the University of Cagliari, Italy, which he invented in 1860 and described in the *Nuovo Cimento* in 1864 under the title of a small electro-magnetic machine. It seems indeed remarkable that this paper should not have at once revolutionized electrical science. This was the original practically of all types of constant-current dynamos. It was built as a motor, but Pacinnotti in his paper recorded that it may be used equally well as a generator of electricity. The advent of Pacinnotti in Paris in 1881, created a positive furor and was an evidence of the importance attached to the splendid work he had done so long before, which has cast undying fame round the name of the modest Italian, who still lives and holds a college professorship in his native country. The jury of the exposition awarded him a *diplome d'honneur*, thus demonstrating their high estimate of his work.

Among the other notable historical relics were shown the huge "Spottiswoode" induction coil giving a spark 42 inches long, which could pierce a sheet of glass six inches in thickness. Holland contributed her great natural lodestone and smaller natural magnets with elaborate decorations thereon, also a large plate machine and huge "crown of cups" composed of 25 Leyden jars and the Ecole Polytechnique of Delft sent the original "Elias" electric motor of 1842.

The Royal Institution of London sent Faraday's priceless apparatus and King's College Wheatstone's, Grove's, and Daniell's valuable early apparatus, such as the first Wheatstone bridge and mirrors for measuring the velocity of propagation of electricity, the first Daniell cell and first Grove gas battery. Italy contributed Volta's original pile and other apparatus, and as before stated, France the original apparatus of Ampere and Pixii.

The English Post Office telegraph exhibit was rich in historic relics of incalculable value. Among those shown were the pith-ball telegraph of Ronalds, the automatic sender of Wheatstone, Ronald's synchronous telegraph of 1816, a section of first practical underground cable laid between Euston and Camden in 1837 by Wheatstone and Cooke and their double and single needle instruments of 1842 to 1846; Bain's chemical telegraph of 1850 and his needle telegraph of 1843, Highton's gold leaf telegraph and needle telegraph; Henley's 1848 single and double instruments worked by a current generated by the movement of the sending key; Spagnoletti's induced needle and Neale's accoustic dial in which the needle struck a tin plate giving an aural in place of a visual signal. Sir Charles Bright's bell instrument of 1855, Wheatstone's A B C telegraph of 1840 to 1858 and Varley's storage battery for time signaling. Modern apparatus was also shown of the Morse, Wheatstone, and other types.

Mr. Latimer Clark, of England, exhibited his remarkable electrical library, which is said to stand to-day the most complete electrical library in the world and the result of a life's work upon this his pet hobby. Other notable features shown were Hughes' induction balance, Dolbear's condenser telephone, the electric ploughing machine, the plating machine of Siemens, the magnets of which were wound with huge bare copper bars of rectangular cross-section; Trouvé's electric boat and batteries, Tissandier's electrically operated balloon, Schrivenow's "push button" dry battery, Griscom's double induction motor, and the inverted arc lamps shown in the galleries attracted much favorable comment. Electric elevators were shown by Dr. John Hopkinson and by Siemens, and most complete were the departments devoted to cable manufacture, laying and repairing, railway telegraphs and signals, primary batteries, electric lighthouses, searchlights and electro-deposition of metals.

The Congress of electricians held during the Exposition was one of its predominant features, and while the United States was so strongly represented at the Exposition, it was represented in the Congress by but six individuals. Some of the other countries were represented as follows: France, 70 delegates; Great Britain, 38; Belgium, 32; Russia, 16; Germany, 15; United States, 6; Austria, 3; Spain, 12; Italy, 5; Holland, 4; Sweden, 3; Denmark, 4; Norway, 4; in all 28 nations. The six gentlemen who represented the United States were: The American Minister, Prof. Geo. F. Barker, Mayor David Porter Heap, U. S. A.; Dr. Cornelius Herz, Lieut. F. C. MacLean, U. S. Navy, and Prof. Henry A. Rowland.

The Congress was divided into three sections, these divided into sub-classes and these again divided under many separate heads.

The Paris Electrical Exposition, which was opened by President Jules Grevy, Aug. 4, 1881, was a great success in every way, and especially so financially, netting a handsome sum, which it had from the first been decided should be used for the encouragement of scientific work.

The Exposition was to have closed Nov. 15, 1881, but owing to the very pleasant mild weather, it was kept open five days longer, making in all 102 days and 85 nights, the last two nights and days being free to the public and the proceeds from the other three days and nights, 26,009 francs in all, being divided equally between the employees of the Exposition and the poor of Paris.

The Crystal Palace Electrical Exposition of 1881-82.

Following as it did so closely the notable Paris Exposition of 1881, the one held at Crystal Palace, Sydenham, England, in 1882 suffered slightly by comparison, but gained also by the transference to it of many of the most interesting exhibits shown at the former, which, together with much new apparatus, formed a most notable and successful exposition. The British Government was loath to recognize officially the Paris Exposition of 1881, and but for the enterprise and public spirit of the Society of Telegraph Engineers and Electricians and the Society of Arts, England would indeed have been poorly representated.

The following year a far more complete representation was made by the English at the Crystal Palace Exposition. Here again was shown Edison's splendid collection of apparatus, illustrating his work in the various electrical and other fields, and the fine display of the British Post Office and Telegraph Department. Also the gigantic Brush arc lamp with carbons as large as a man's wrist and giving a light stated to be equivalent to 50,000 candles The Anglo-American Brush, Weston, Maxim, Crompton, Siemens, Jablochkoff, Werdemann, Gülchen, Pilsen, Joel, Gravier, Arago Disc, Lontin, Gramme and other companies showed their complete installations of dynamos, both direct and alternating-current arc lamps and semi-incandescent lamps. The displays made by the Edison, Swan, Maxim, the British Electric Company and others at Paris were supplemented by the exhibits of new rivals in the field of incandescent lighting, the Lane Fox Company having had a particularly interesting exhibit. Among the telephones exhibited were the condenser type of Prof. Dolbear, those formerly brought out by Prof. Bell and Edison's motograph receivers, and carbons transmitter telephones. The incandescent lamp came forward for the first time in its application to advertising and spectacular effects, the Edison exhibit showing electrical signs and various applications of colored incandescent lamps. Messrs. Negretti & Zambra had a huge white reflector, with 30 small Swan lamps around the edge, by means of which many portraits were taken. Magnus Volk showed a small circular electric railway in operation on the grounds of the Exposition. B. Verity & Sons exhibited their remarkable electrolier, containing hundreds of Edison lamps arranged as flowers growing from a huge basket, weighing many hundred pounds, and composed of over 3000 pieces of brass, all hand-made.

The dynamo installation attracting a great deal of attention was that shown in the Edison exhibit, comprising 12 Edison dynamos of the single upright magnet type, driven by three semi-portable engines, transmitting power to six sets of friction clutches and enabling the throwing out of either one, two, three or four dynamos and the stopping of one engine without interfering with the lighting. One regulator controlled by a special arrangement the fields of the machines. This plant on the whole was a most notable installation, considering the time and place.

Those desiring full particulars concerning the Crystal Palace Exposition should refer to the report of the United States Government submitted by Lieut. F. J. Sprague, who was a delegate to the Exposition and honored by being made secretary on the Jury of Awards. This exposition was followed in 1882 and 1883 by a joint Gas and Electric Light Exposition, which also proved highly successful.

Discussion of the Paper on Vacuum Tube Lighting.*

Mr. Steinmetz opened the discussion by saying that he took exception to the statement made in the paper that it "represents radical departures in principle, in apparatus, and in the nature of the current."

The electrostatic discharge is produced by a sudden change in the electric circuit, consisting of a make-and-break of the circuit. This is precisely the same method as used since the early days of the Ruhmkorff coil, with the only exception that the interrupter is placed in a vacuum.

The absence of a secondary coil is not new, but not desirable where the primary E. M. F. is very low, as a battery cell, as stated earlier in the paper.

The allusion to the ponderous alternator, oil, transformers, magnetic blasts, the millions of volts required, etc., is obviously gross exaggeration.

One disadvantage of this vacuum interrupter, compared with the condenser discharge across a spark gap, has been already noticed by the lecturer. While the condenser discharge through the spark gap makes its own frequency, with the vacuum interrupter the circuit has to be carefully adjusted to the condition of resonance.

That the nature of the current produced by the vacuum interrupter does not differ in any way from that of any electrostatic discharge —either oscillatory or steady, according to the circuit conditions—is self-evident. The phenomena produced by this electrostatic discharge in vacuum tubes, and described in the paper as the luminescence of the conductor and of the electrostatic field of force, the diffused glow at a different degree of vacuum, etc., have been observed many times before, and exhibited with nearly the same brilliancy, for instance, at the World's Fair in Chicago by Mr. Tesla. The use of external electrodes in vacuum tubes is old.

The luminescence of the interior of the spiral in no way contradicts Faraday's experiment, since the interior of an open spiral is obviously not the interior of a charged body, and Faraday's experiment, as well known, refers only to electrostatic charges at rest, but not in motion.

What cause the lecturer has to claim an irregular period for the oscillations produced by the condenser discharged through an inductive circuit, Mr. Steinmetz said he failed to see, since it was with such discharges that interference and nodal points of electromagnetic waves have been observed.

The wave length of an electric oscillation is not shorter if the break is quicker, as stated by the lecturer. It is well-known that the period of oscillation is entirely independent of the rapidity of the break, and only the amplitude can be affected thereby. Thus the conclusions drawn herefrom are erroneous.

The calculations on page 14, on the counter E. M. F. of the other gap and its particular and radically novel features, are too fantastic to pass any scientific scrutiny.

A number of other statements in the paper are unintelligible, as "natural period of a coil," or "governing the period of oscillation" —by the way, through the high resistance of the vacuum tube, the discharge is probably not oscillatory at all, but steady—or "compensating for the long wave length by a discharge coil," or the action of return wire, etc.

Other remarks border on mysticism as, "striking nature's keyboard to the tune of 500 trillions of waves per second," etc.

In general Mr. Steinmetz regretted that a large part of the paper is written in a style more befitting a sensational newspaper than a scientific or even technical society.

After criticising what the paper says, he adds a few words regarding what it does not give, but what such a paper, to be suited to such a body as the A. I. E. E., should give.

At the risk of being included by the lecturer among those lacking in information, he must nevertheless raise the all-important question, "How many watts per candle-power do you require?"

Public demonstration is not very suitable for such tests, but they should have been made before in the laboratory and their results communicated to the society.

Thus, while the paper is very interesting as showing improvement in illumination by Geissler tubes, no data whatever are brought forward regarding the only and all important question, "How does the power required for lighting with Geissler tubes compare with that required for the same illumination by incandescent lamps?"

He adds in closing that the paper would have been essentially improved if all reference to Galileo about the interference of the inertia of the learned with the progress of science, etc., had been omitted.

Mr. J. P. Wintringham: This paper seems to have some interesting new matter, but the author has written a little carelessly, and I would note two or three lapses. He speaks of the counter E. M. F. of the air gap. The effect is not a counter, but a direct E. M. F. and is due to self induction, not to the air gap.

He speaks of a high-frequency oscillating discharge, which term has a special technical meaning among electricians, referring to the discharge of a Leyden jar, etc.

He seems to deal with a branched circuit, the current of one branch being periodically interrupted, the current in the other branch being also periodic. There does not appear to be any charge and discharge or any oscillation involved.

What I have said applies to the lamps with two electrodes. Some of the lamps had only one, and the tubes were without any electrodes. Here there would be condenser action, charge and discharge.

Dr. Nichols: We have two absolutely different theories with regard to the efficiency of the Geissler tube discharge. Measurements were made in Zurich by Dr. Staub on the tube itself, in which he got what might be called the efficiency, which ran up sometimes as high as 90 per cent. That means that the spectrum of this source is very largely luminous in its character. I think this is an error which is much wider spread than definite knowledge of the fact that this is a light almost without heat and has been perhaps misleading to many. A few years later Prof. Armstrong made other measurements with the Geissler tube.

He found as a result of calometric measurements, as compared with the amount of energy expended in running such a tube, that the efficiency, instead of being in the neighborhood of 90 per cent., as shown by the measurements simply, fell to something like 10 per cent. In order to secure a vacuum tube discharge which shall be very much higher than the electrolytes of other metals, you have got to devise some means of generating that discharge which shall be free from the losses which exist with any of these ordinary make-and-break apparatus.

Mr. L. M. Pinolet: I would say that measurements made of Mr. Moore's apparatus the night after the lecture showed that the vibrators with their magnet consumed one eighth of an ampere each at 450 to 500 volts. The slowing down of the dynamo was due to the fact that the motor was run with a starting box, the resistance of the starting box being only partly cut out. Since the lecture a change has been made in his apparatus which has reduced the current consumption to about one tenth of an ampere. Measurements made on the apparatus show that the brightest tubes take the least current.

Prof. Anthony: I would like to know exactly where the ammeter was placed when these measurements were made?

Mr. Pinolet: It was placed in series with the vibrator and its magnet; that is, placed between the vibrator and the source of current of 500 volts.

Mr. Wolcott: In justice to Mr. Moore I will say that he has since succeeded in getting a much better quality of light than that exhibited at the Institute.

Mr. Hering: In connection with this light, the question is asked how many candles were used per watt. It seems to me that it is not quite right to put the question in that form. I agree with Mr. Moore in his statement that it is not altogether a question of watts per candle. The real question is how much energy does it take to light up a given room so that the effect is the same—the effect on the eye—for after all we generate light for our eyes, and therefore if the effect is the same, it does not make any difference to us how many candles of light there are generated in that room. It is well known that if you take a certain amount of flux of light and concentrate it all in one point, it becomes clear and the retina of the eye contracts, while if that same amount of light were distributed equally, as reflected from white walls or from the surface of Geissler tubes, it would produce a much better effect on the eye and would produce what we call a much better illumination. So that I do not think much stress ought to be put on the amount of candles produced per watt in the system.

Mr. A. E. Kennelly: Mr. President, it has given me great pleasure to witness the distinct advance that Mr. Moore has made over the Geissler tube in the production of light by high-tension discharges. At the same time it is a direction in which advance may be looked for, and in which we may hope that success will ultimately be achieved.

* Presented by D. MacFarlan Moore at the regular meeting of the American Institute of Electrical Engineers, April 22, 1896.

Yet I think we should face the facts as they are, if only for the sake of having an accurate criterion as to how far progress is made in this direction, and I think we should face the question as to how much light is produced for so much energy delivered. Of the amount of 40 watts, which are said to be supplied to one of Mr. Moore's tubes at the present time we cannot believe that the 40 watts are produced in expending that light, but rather for exciting the magnet whose discharge produces the light. It is just in the same way as a 50-cp lamp has 50 watts to produce a certain quantity of visible light. The fact that the tube occupies an extended space and offers an extended surface does not really come into the question. What we want to know is how many units of light (not candle-power necessarily, that is only another way of stating it) are produced from this tube, considered as a source of light, for the alleged 40 watts which are supplied to it. That is a perfectly definite question capable of a perfectly definite answer under the conditions of photometric measurements, and if that answer can be given to us at the present time it will at least afford us a valuable criterion by which not only to profit by the advance which Mr. Moore has made in the art, but to fairly gauge it and to tell what further advance in the future may be expected.

Mr. E. E. Ries: I believe perfectly in what Mr. Hering and Mr. Kennelly have said about the fact in discussing this new method of Mr. Moore's, that it is not proper to compare it with such standards of candle-power; that is to say, systems of lighting to which we have been heretofore accustomed. The new system operates by diffused light; that is, a lesser intensity of light, given forth by a larger emitting area. Now, if it can be shown that the luminosity given to an apartment or room is sufficient for practical purposes; that is, for the purposes of reading or working by, at a fairly economical cost it will denote that a considerable advance has been made. I do not think it wise for the members of the Institute to condemn a new invention at the outset simply because it has not arrived at that stage of efficiency which if the theoretical principles underlying it are true and correct it will probably eventually attain. It is possible that the waste incidental to the excitation of the magnet, and other waste due to the air gap, etc., may eventually be minimized. I think it well to defer giving a hasty conclusion until that point can be determined.

I hope that future developments in this respect will show that something valuable may be expected from this new method of lighting.

Mr. Steinmetz: I must protest, Mr. President, against the imputation that any one wanted to condemn the paper. What we want is to get the exact data. What was condemned was the means of getting the exact data. That is all.

Mr. Hering: We know the arc light is much more efficient than the incandescent light, yet we use the incandescent light because we can distribute it. Now I think if in this light the amount of energy is greater than in the incandescent light per candle it might nevertheless be a more economical way of illuminating a room.

Mr. Perry: That brings up another point. I think all of us who saw this exhibition were guessing as to how many incandescent lamps were distributed through the hall to enable a person to read with equal ease. All the guesses that I heard gave a very small number. Mr. Hering's point was that the larger surface ought to give us better result. That is so, and measuring incandescent lamps would not be a fair way of measuring for the tube. There is some data in regard to these tests. There are a great many who saw these instruments work. I could see the motor part of the time, and the rest of the time I could see the dynamo, and my impression is that there was not less than ten horse-power generated. If we hear a 7½-hp motor laboring as that was, it is a pretty sure indication that the energy must have gone somewhere. If we divide it up among those 27 tubes and it gives no more diffused light than a comparatively few 16-cp incandescent lamp then it would seem to indicate that the light was a very expensive light.

Mr. Kennelly: While I agree in some respects with the last speaker, I think that matter ought to be viewed from a somewhat different standpoint. We have here a new means of electric lighting. I do not suppose that anybody thinks that that means has advanced to a state where it can be called practical. That is not the question at present. The question now is, what is the possibility of this means becoming better in the future? In that point of view it becomes of interest to know just how the fact stands. Now, light is something to see by, or something to admire. Measured in units unfortunately it is not very well agreed on. These tubes produce so much light, and that light is capable of being measured. They have so much energy that is capable of being measured. In the Institute the other night, by an arrangement of white screens behind the tubes and gauze above them, an effect was produced. But we want to know how much light do these tubes produce for a given quantity of energy. Then we shall have something by which to judge the future success. The question, it seems to me, is beyond us at the present time.

Prof. Anthony: For my part I cannot see that. The efficiency, or the value of these tubes as illuminants I cannot see. The candle-power is simply to measure the flux of light, whether it comes from a small point or a large one. In the case of the illumination by means of these tubes, the tubes present a large surface. It may present advantages as regards the distribution, but that makes no difference with the amount of candle-power per watt. In regard to the results the other night at the Institute meeting, I took pains, while the tubes were being used, to observe how well I could see to read, and tried to compare that as well as I could with the ease with which I could read by means of the incandescent lamp. When the 27 tubes were in use it was certainly very much more difficult to read than when the usual lamps were employed for lighting the hall. I think that was evident to everybody. How much more difficult it was I could not say. Mr. Moore has certainly done a great deal, and has made a great advance in vacuum tube lighting. He has accomplished something that we have never seen done before. But at the same time we would like to know just how much light he will give us per unit of energy expended.

Dr. Nichols: If the photometer is not for the purpose of measuring the illuminating power of light what is it good for? The work of this committee would seem to be wasted if when we get through we are not going to be able to measure the power of all sorts of light. The light which falls upon the disc of the photometer produces there an effect which is entirely independent of the area of the source. It does not make any difference to the man who is looking at the photometer whether the source is concentrated or not, but if you test your light by another means the question of diffusion does come in. If you are standing with your back to an arc shadow you cannot read. There is a benefit which is obtained by distributing your light. All other benefit than that of getting rid of back shadows is entirely fictitious.

Mr. Ries: It does not seem to me to be a question of relative candle-power so much as the amount of energy required to produce the light. When it comes to a question of measuring light by candle-power that is one thing, but so far as its commercial use is concerned that is quite a different thing. If we take an arc light, which will give us 2000 candle-power with an expenditure of one horse-power of mechanical energy, we will, by expending the same amount of energy, be able to get at the most about 200 candle-power out of a number of incandescent lamps, yet because the latter are only one tenth as efficient as the arc lamp that is no reason why we should dispense with incandescent lamps. If vacuum-tube lighting can be brought in the future into commercial use for the lighting of the interior of rooms it will have a field peculiarly its own. It will not drive out the electric light or the incandescent light, but it will open up a new field for decorative effects where intense luminosity is not required, and it is perfectly conceivable that with a satisfactory means of vacuum-tube lighting, which of course is not prohibited, a great many practical uses may be found for it. From that point of view I say that it is not so much a question at the outset to criticise the new method or the improvement in the Geissler tube method, simply because at present, from our lack of information, we have not got the data which shows us exactly what it will cost. If the cost is reasonable—even if it should be greater than the cost of incandescent lighting—it may still have a future before it. It seems to me that the question now is, to discuss the matter from the standpoint of an improvement in lighting rather than to criticise it at the outset too strongly from the point of view of its advantage over other forms of light.

Mr. Wolcott: One reason why the members have all taken the stand of the efficiency of this light is that the paper spoke of the incandescent light as very wasteful. The idea was that this was a very cold light which took very little energy.

Mr. Kennelly: I am not here to criticise Mr. Moore's splendid work in this direction, but we want to know just how much to admire it. Now, if we have from Mr. Moore a statement of how many candle-power he can produce, why there is an accurate criterion by which we can measure his efforts.

Mr. Howell: There is one thing that was brought out by Mr. Moore that night which has not been touched upon, and that is the

difference in color between the vacuum-tube light and the incandescent light. You will remember that he held up a tube in a reflector, and alongside of it his reading light, to illustrate the difference in color, stating that it was his belief that the color of the tube light was very much superior to that of the incandescent light. It was my impression that the color was a very poor one, and that the whiteness, or greenness, as I called it, of the light was a very great disadvantage to it. The light to my eyes that night was rather trying. It had the effect of a violent light. The greatest objection I had to it was the color, and the contrast which he made between his light and the other was the greatest argument in my mind that he used against it.

The President: Mr. Moore has just come in. We should like to hear from him.

Mr. D. McFarlan Moore: Mr. President and Gentlemen:—The ideal light will undoubtedly be reached when we can produce by artificial means a light which is the same as daylight. Since the light was exhibited to the Institute an improvement has been made in it and I can produce at this moment tubes with absolutely the same spectrum as daylight. The vacuum method is the only method which represents itself for our use in order to produce a light which will be anywhere near a counterpart of daylight—a light which will be radiated and have no shadow. In relation to efficiency, of course it was understood that the paper was presented in view of the advance that had been made. In order to appreciate that advance a person must understand how very inefficient previous experiments and methods had been. With reference to the economy of the light, I would say that vacuum-tube light has undoubtedly been proved to be economical over previous systems in which a break in an electric circuit in the open air was used in order to produce the secondary current which would have certain properties necessary to produce the agitation in the tube and cause the light. In all those systems the break came into the system somewhere. Anybody who has experimented with a break in the open air knows that it is very remarkable how much energy can be wasted. Now, when that arc is placed in a vacuum which runs perfectly true, it is apparent without any further discussion that there has been an enormous saving somewhere. Some tests have been made as to the range of legibility. That is the only way by which we can get any idea of the consumption of power. It was undoubtedly a fact that objects on the wall of the Institute could be discerned a great deal better with the tube lighting than they could with the 25 incandescent lamps. The exact power being consumed there was at no time more than two amperes. Now, that is the only basis we have to calculate from, as far as power is concerned, that you could distinguish objects better with two amperes, which is of course a less amount of power than in the 25 incandescent lamps. Since then I have well nigh cut the power required in half, and again increased the efficiency of the light. In fact, it is difficult to say just what power will be required to produce the same amount of light with the break in the open air; but if the same amount of light were to be produced with the break in the open air and by the inductive method alone I am not exaggerating to say that the increase of efficiency in the latter is about 11,000,000 per cent. This sounds outlandish, but it is a fact. I do not know that there is anything more that I can say, except that I will take great pleasure in explaining the light to any one who wishes to examine it. I will also state that the spectrum is absolutely continuous, which is a surprise.

Mr. Wolcott: I would like to ask Mr. Moore one question. On page 2 of his paper he says: "As a device for transforming electrical energy into light, the vacuum tube is very efficient. The majority of authorities place it at about 70 per cent. and the incandescent lamp at 2 per cent." I would like to know what is the basis for that. Does he mean 70 per cent. efficiency which is supplied to the electrodes per luminous variation?

Mr. Moore: Yes, undoubtedly. I wish also to add that the idea in showing the difference between the incandescent light and the vacuum-tube light was merely to show that the vacuum-tube light had very little waste in the heat. With reference to efficiency of course it is understood that I referred to the amount of power consumed at the terminals of the lamp, and that this system of lighting without heat is merely a step in advance. We must come to it, and rapidly, and it is merely a step in that direction. The heat is not all removed, but we are approaching that end.

Prof. Anthony: It seems to me that a good place to put a voltmeter and an ammeter is in the circuit that drives the motor. If we put the voltmeter and ammeter in the circuit which drives the motor then all the question as to the measurement of this extremely fluctuating current that goes into the tube by means of the ordinary instrument, as to whether that gives us an accurate measurement or not, would be disposed of. We could tell then very nearly what amount of energy is required to operate the tube.

Mr. Joseph Wetzler: In order that you may understand, gentlemen, just exactly how these tests were made, I will draw a diagram on the board showing the disposition of the instrument. If you recall the system, it consists of a generator, which, in this case was supposed to be at 500 volts, although at times it rose a little above that. The tube itself is taken as a shunt to the vibrator. The voltmeter was placed across the dynamo terminals, and the ammeter was placed in series next to the dynamo. You will notice that all the current that could possibly have gotten into that tube would go through. What I used was a 610-volt direct-reading voltmeter, and a milli-ampere-meter. I made tests on five different tubes.

Tube No. 5, which was a very good tube, showed this peculiarity. The voltage was 500, and the milliamperes 88. The second reading also showed 500 and 88, but occasionally there would be momentary rises to 120, just for an instant, say for a fraction of a second, showing apparently some resonant effect. The watts to be calculated from these figures are, of course, self-evident. Taking this good average tube, 110 and 485 gives 53.35 watts. Some of them are lower. This one would be 44 watts and another of 42 watts. On another evening I made other tests which showed even better than that. One reading gave me 740 volts and 65 for the milliamperes, which was about 30.5 watts.

All those tubes were about seven feet long. In fact, they were the same tubes that we used at the Institute lecture. No measurements were made on the illuminating power of the tubes. They were all in good condition except that one which I have referred to as a bad tube, which was evidently lacking in brightness.

Mr. Moore: I believe it was stated before I arrived by somebody that the motor appeared to be overloaded. It is quite remarkable when you consider all the motor experts there were at that meeting that every one presumed that the motor was overloaded, and it only shows how unsafe it is to be too sure of anything. Here was the motor, and here was the dynamo (illustrating on blackboard). When the dynamo field rheostat arrived it was found, when it was connected in circuit, that you could turn the handle all the way off without affecting the voltage in the slightest degree. Therefore, it was a useless piece of apparatus, and it was not used. The motor starting box had seven points. Now, at no time during the evening were more than three points cut in in the motor box, and I think most of the time only two. Of course, anybody who is familiar with that apparatus knows very well that when you have a motor with only two sevenths of its starting box cut out when you put a slight load on it it will lose its voltage. That was the whole truth. Of course if the attendant had turned this starting box all the way around and cut it all out then it would have been all right, as it was the following night.

Dr. S. S. Wheeler: I attended the Institute meeting, and I thought I noticed the belt between the dynamo and the motor slipping. I would like to ask Mr. Moore about that.

Mr. Moore: Dr. Wheeler must have been mistaken. A number of men who are competent to know how tight a belt should be stretched all agreed that the belt was all right. It worked perfectly merely by throwing the resistance of the starting box out.

Prof. Anthony: During one stage of the experiments I am quite sure that the motor starting box was not all cut off. When they first attempted to start up the large tube, I saw the assistant go and turn it off, as I supposed, and I supposed it was fully turned off. I feel quite sure that it was. In regard to the laboring of the machine, it was not the laboring of a machine that was working with the starting box partly turned off, but it was the laboring of a machine that was overloaded.

Mr. Moore: In response to that I must say that Prof. Anthony is entirely mistaken. I have the very best evidence to show that that starting box was not cut off. I know that the following evening the apparatus worked perfectly and on several other occasions. Indeed, it is working perfectly now, or was a few days ago when they changed the motor.

Mr. Kennelly: Fortunately it is not a matter of any consequence, gentlemen, whether the motor was operated or not. If these tubes take from 40 to 60 watts we know they will give that amount of illumination with that amount of power. Therefore, we can for-

tunately consign to oblivion the question whether the motor was overloaded or not.

Prof. Anthony: I don't feel so sure of that.

Mr. Wetzler: Perhaps I may be allowed to state that the measurements I made were made with two different types of instruments and on two different days. One was a direct-reading ammeter, and the other was an alternating and direct-reading Westinghouse instrument.

Prof. Anthony: I do not think in an interrupting circuit that any of those instruments will properly measure the energy consumed. The sort of current that is obtained there by that interruption is something totally different from any alternating current, and it seems to me that it may very well be that the voltmeter and the ammeter would not measure truly.

Mr. Perry: I have felt the same way that the last speaker has, that neither the direct nor the alternating-current measuring instruments would be likely to give us results which would not be open to some question.

Mr. Moore: Mr. Wetzler has told you that he did not measure but one at a time. I measured a number all the same time, the current consumption being the same. With reference to Prof. Anthony, he seems to be determined that that motor was overloaded. Now I may be able to help him out in that matter. As is well known, when a motor under those conditions has a load placed upon it, it will drop in its speed. When the dynamo in those conditions on a voltage drops from 450 down to less than 100 of course the vibrators would stop vibrating, and the moment they do that there is a short circuit right through the coil, and immediately the amperage would run up enormously. So that may well explain why the motor appeared to be overloaded. The fact of the matter is, however, that it never was overloaded. I wish to state once more that this matter of efficiency is absolutely secondary. I was able to light up a room—the first room in the world to be so lighted. So it is merely put forward as an advance in the art, irrespective of the question of efficiency, although there is nothing to be ashamed of in the line of efficiency.

An Analysis of Transformer Curves.*

BY CHAS. K. HUGUET.

One of the most noteworthy features of Prof. Ryan's famous paper on "Transformers,"[1] before this Institute, was the distortion of the primary current curve on open secondary. This distortion Prof. Ryan ascribed to hysteresis, and this opinion seems to have been held by Fleming,[2] Steinmetz,[3] and every other writer since that time, with the single exception of Prof. Rowland[4].

Dr. Sumpner[5] had previously shown that, assuming hysteresis

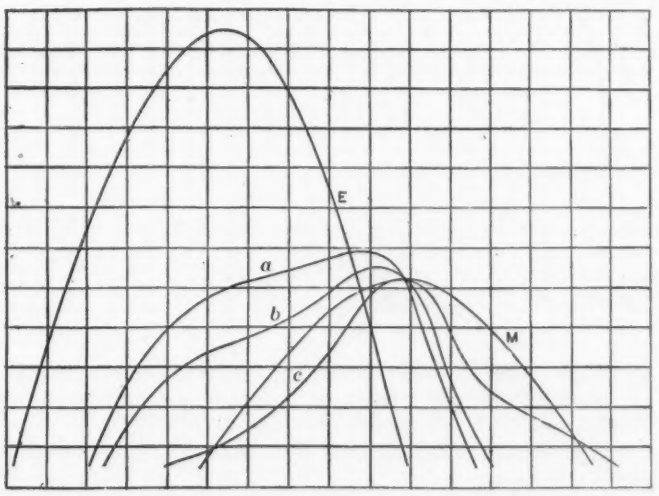


FIG. 1.—40 LIGHT TRANSFORMER, 100 *v* 140 ∽.

absent, a variation in the value of μ will superpose on the sinoidal magnetizing current a system of higher harmonics, causing it to become a symmetrically peaked curve. Prof Rowland, however went further, and declared that the presence of the distorting harmonics is due, not to hysteresis, but to change in permeability, the effect of hysteresis being capable of representation as a simple resistance. However, he simply expressed this theory mathematically, without giving any experimental verification, and it is doubtless for this reason that the results of his paper have not been accepted in their entirety. This apparent conflict of opinion seemed to warrant further investigation, and it was the object of experiments conducted by the writer at Tulane University in June, 1895, to throw light on this question by analyzing the current curve into its various components.

The low-tension coil of a 40-light Fort Wayne transformer was used as primary, and a run made at 100 volts and 140 ∽. The

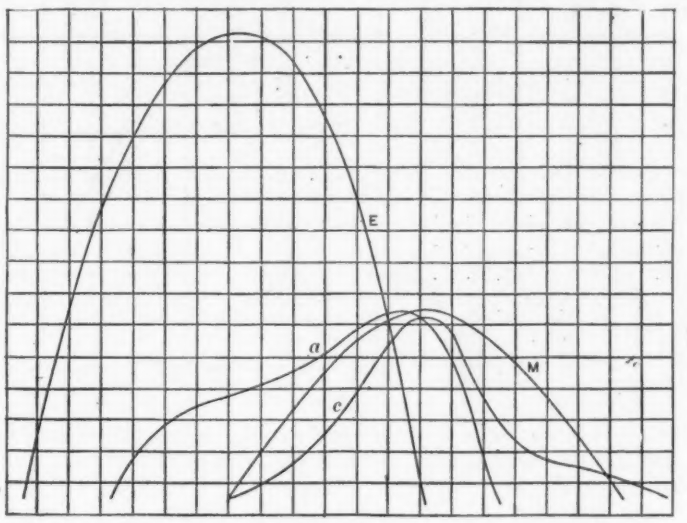


FIG. 2.

method employed in the measurement of the instantaneous values was essentially similar to the telephone method described by Nichols[6], a galvanometer being substituted for the telephone. A run was also made at 50 volts and 70 ∽, and the determination of the watts lost under these conditions, as well as under the preceding ones, enabled us to discriminate the eddy from the hysteresis losses in the usual manner[7]. In this case the total loss at 100 volts and 140 ∽ was 55 watts, of which 20.7 watts were due to eddies, and 34.3 watts to hysteresis. If we divide the watts lost by eddies by the E. M. F. applied, we shall obtain the effective current due to eddies, and the ratio of this to the aforesaid E. M. F. is the conductance due to eddies.

If the instantaneous values of E. M. F. be multiplied by this con-

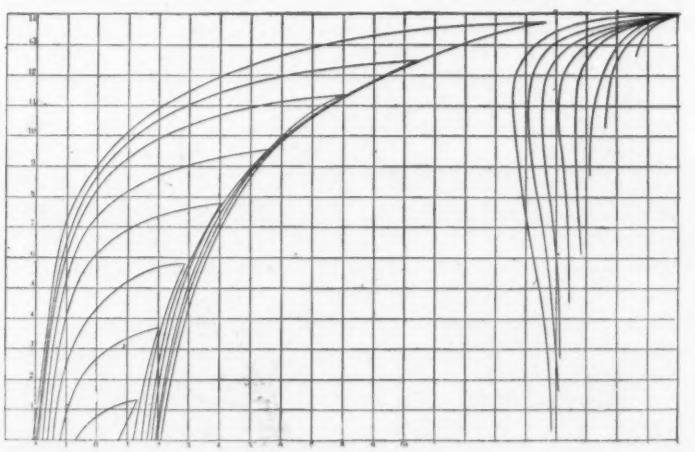


FIG. 3.

ductance, and the resulting eddy current curve be subtracted from the original current curve (*a*, Fig. 1), the remainder will be the hysteresis curve (*b*), *i. e.*, the curve that would be derived from the hysteresis loop. If in the same way we determine the conductance due to both eddies and hysteresis, *i. e.*, we represent the hysteretic loss as one due to a simple constant resistance, and substract the effective current curve thus determined, from the original current *a*, the remainder *c* will be a true wattless current, since the curve subtracted itself accounts for the watts lost. In Fig. 1 this wattless

* A paper presented at the Thirteenth General Meeting of the American Institute of Electrical Engineers, New York, May 20, 1899.

[1] Ryan: "Transformers"; *Transactions*, vol. vii, p. 1.

[2] Fleming: *Alternate-Current Transformer*, vol ii. p. 454

[3] Steinmetz: "On the Law of Hysteresis (Part III.)"; *Transactions*, vol. xi., pp. 570, 616.

[4] Rowland: "Notes on the Theory of the Transformer"; *Philosophical Magazine*, vol. 34, p. 54. Also THE ELECTRICAL WORLD, July 9, 1892.

[5] Sumpner: *Philosophical Magazine*, June, 1888, p. 468.

[6] Nichols: *Laboratory Manual*, vol. ii., p. 182.

[7] Steinmetz: "On the Law of Hysteresis"; *Transactions*, vol. ix., p. 50.

remainder is very fairly symmetrical with respect to the flux curve M, and is of the peaked character to be expected with permeability variable and hysteresis absent. A similar treatment of Prof. Ryan's curve[8] yielded a wattless remainder (c, Fig. 2) of similar character. These results seemed to verify Prof. Rowland's theory, at least approximately.

But equally strong proof is afforded by Figs. 7, 8, 9, 10 in Steinmetz's "On the Law of Hysteresis" (Part III.),[9] for here the subtraction from the original wave, of its equivalent sine wave, leaves a wattless higher harmonic, in each case very nearly symmetrical with respect to the maximum magnetization. Hence these higher harmonics must be due almost entirely to variation in permeability, since hysteresis is essentially unsymmetrical with respect to the magnetization.

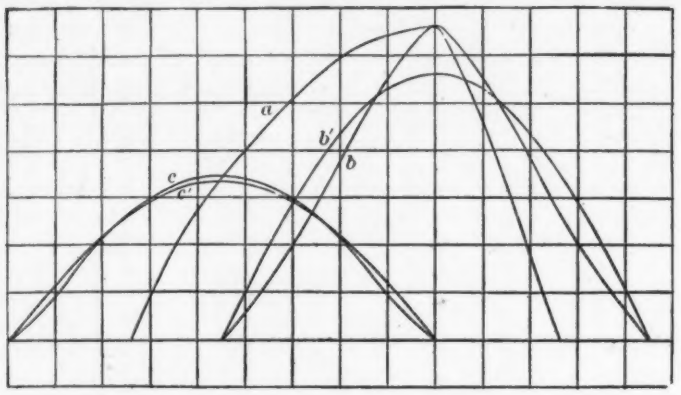


Fig. 4.

It is worthy of note that in Fig. 10, in which the original current is most distorted, the wattless higher harmonic is most nearly symmetrical.

The state of the case seems to be, briefly, this: A variable value of μ will superpose upon the wattless sinoidal magnetizing current a symmetrical system of higher odd harmonics, which, since they are symmetrical with respect to the zero of E. M. F., will also be wattless, and the resultant magnetizing current will be a wattless peaked current. If now the transformer be heavily loaded, the sinoidal energy-current will completely hide the magnetizing current both in shape and phase. If, however, the energy-current be comparatively small, we will have a current resultant from a sinoidal current in phase with the E. M. F., and a peaked current 90 degrees behind it, and tending to unduly "boost" the latter half of the energy-current. Hence the dissymmetry is due simply to the conflict between the sine current in phase and the peaked current 90 degrees

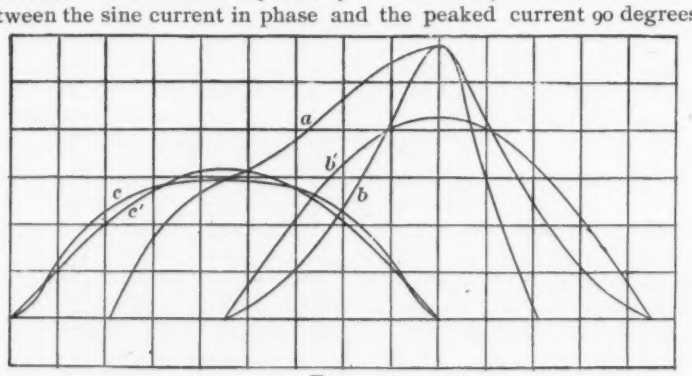


Fig. 5.

behind. If either component be very large, comparatively, the resultant will tend to become symmetrical, in the one case a sine, in the other a peaked curve. The sinoidal energy-current may be due to eddies, hysteresis, or secondary load, the effect will be the same

Curves a, b, c, Fig. 1, show very clearly the effect of the successive elimination from the original current curve of the sinoidal energy-components, due respectively to eddies and the hysteretic loss.

If we take a hysteresis loop, plot a sinoidal flux curve with the same maximum, and then, at each successive epoch, plot the current value corresponding in the loop to the flux value at that epoch, we shall thus obtain the magnetizing current curve. This method was first used by Humphrey and Powell[10] and has been employed by numerous later writers.

[8] Ryan: "Transformers"; *Transactions*, vol. vii., p. 1.

[9] *Ibid.*, vol. xi., pp. 718, 719.

[10] Humphrey and Powell: "The Efficiency of Transformers;" *Transactions*, vol. vii. Also *Electrical Engineer*, vol. x., 1890, p. 16.

If, however, at each epoch, we plot a current value, the mean of those given by the loop for rising and descending magnetization, we shall thus obtain the wattless magnetizing current. This curve is essentially symmetrical with respect to the flux curve, and consequently, as stated, wattless.

If this wattless magnetizing current be subtracted from the original current, the remainder will be the hysteretic current curve, or, what is the same thing, we may plot at each epoch the half-width of the loop at the corresponding flux. A curve plotted between the flux and the corresponding half-width of the loop may be called a *hysteretic characteristic*.

Fig. 3 gives a set of half loops from Ring III. in Ewing and Klaassen on the "Magnetic Qualities of Iron,"[11] with the corresponding hysteretic characteristics, plotted with their maxima together for convenience of comparison.

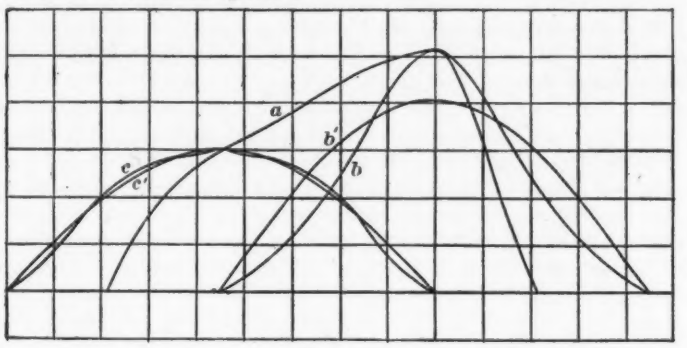


Fig. 6.

Figs. 4, 5, 6 give the magnetizing current curves for sinoidal flux curves, for B_{max}, 1360, 3720 and 5830 respectively, derived from these loops in the manner above described, with additional curves derived by analysis of the first. In each figure, a is the original magnetizing current curve, b the wattless magnetizing current, b' its equivalent sine, which represents the flux curve in shape and phase, c the hysteretic current, and c' its equivalent sine.

The half-width of the loop is zero for maximum flux, and for any flux has the same value, but opposite sign for increasing and decreasing magnetization. Hence the hysteretic current has the same zeros

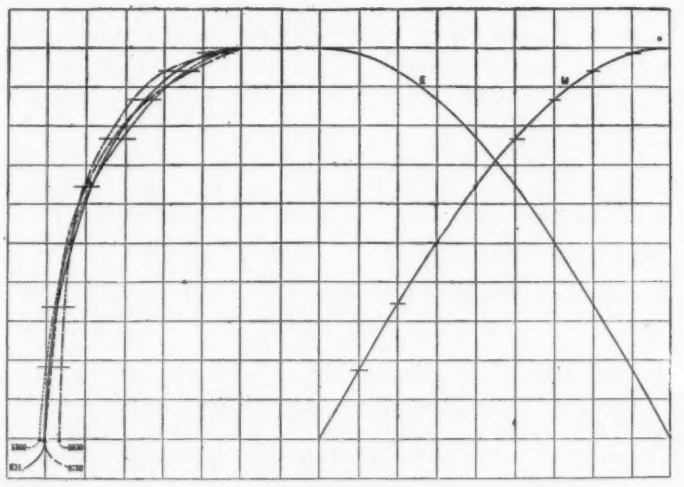


Fig. 7.

as the E. M. F. curve, and is essentially symmetrical with respect to it, consequently essentially in phase, but it remains to determine the conditions under which it also has the sinoidal form.

In Fig. 5, for $B_{max} = 3720$, c lies very close to c', having indeed the same maximum.

In Fig. 4, for the lower range, 1360, the approximation is very close, but c is slightly more *pointed* than the sine.

In Fig. 6, for the higher range 5830, the approximation is not quite so close, but c is more *flattened* than the sine.

These approximations are quite close, but it is easy to determine the exact form of hysteretic characteristic necessary for a sinoidal hysteretic current, when the flux curve is sinoidal.

Let E and M (Fig. 7) be sinoidal E. M. F. and flux curves, respectively, drawn the same size for convenience. Assume the hysteretic current due to a simple resistance, *i. e.*, $H = \frac{E}{R}$ (instantaneous

[11] Ewing and Klaassen, "Magnetic Qualities of Iron"; *Transactions of the Royal Society*, vol. 184 (1893), p. 998.

values). Then plot a curve between the flux value at each successive epoch and the hypothetical hysteretic current at that epoch.

A hysteretic characteristic of the form thus determined will obviously satisfy the conditions.

This curve is the quadrant of an ellipse.

For $E^2 + M^2 = A^2$, where $A = E_{max.} = M_{max.}$ But $H = \frac{E}{R}$ by assumption, whence $H^2 R^2 + M^2 = A^2$, which is an ellipse, H and M being the variables.

For our purpose the quadrant tells the whole story, so that we may say that the assumption, for sinoidal E. M. F., of hysteresis as due to a simple resistance, is absolutely correct when the hysteretic characteristic is a quadrant of an ellipse.

If we compare this ideal curve with the hysteretic characteristics for the ranges used in Figs. 4, 5, 6, plotting each characteristic to a horizontal scale proportional to the virtual value of its hysteretic current, as indicated by its equivalent sine, we see the same manner and degree of approximation as in the cyclic curves. The ellipse is intersected by horizontal bars, indicating the successive epochs in the cyclic curve, and by reference to these it is seen that each characteristic intersects the ellipse at a point corresponding exactly to the intersection of the cyclic hysteretic current by its equivalent sine, and that the relationship is in every respect identical.

A glance at the hysteretic characteristics in Fig. 3 shows that for ranges higher than 5830, the hysteretic current curve will not only be more flattened, but actually depressed in the middle. But while the increased distortion of the hysteretic current will introduce higher harmonics, yet the rapid diminution in the permeability on approaching saturation will introduce them much more rapidly with increase of the range, so that the distorting influence of the hysteretic current will be comparatively slight even at the higher ranges. At the highest ranges, as the one given by Steinmetz,[12] mentioned above, $B = 16{,}000$ the inordinate peak of the wattless magnetizing current throws into oblivion higher harmonics from any other source.

To conclude: for sinoidal E. M. F.

(1) Hysteresis may in all respects be replaced by a constant resistance if the hysteretic characteristic be the quadrant of an ellipse.

(2) This condition is approximately satisfied for moderate ranges of magnetization (such as are used in practice), in reasonably good iron, and the higher harmonics are negligible. There will usually be a particular range that will give a nearly perfect approximation. On contraction of the range the hysteretic current becomes more pointed than the sine, and on expansion beyond the critical range more flattened than the sine.

(3) The increased distortion of the hysteretic current for higher ranges will cause an increase in the higher harmonics, but the rapid diminution in the permeability on approaching saturation will cause a much greater increase in these harmonics, so that even at higher ranges the distorting influence of hysteresis is comparatively slight.

As a final conclusion, then, we may say that Prof. Rowland's hypothesis that the higher harmonics in the transformer for sinoidal E. M. F. are due, not to hysteresis, but to variation in permeability, and that the effect of hysteresis may be represented by a constant resistance, is approximately correct, for reasonably good iron, is very nearly correct for the moderate ranges used in practice, and may, under certain conditions, be absolutely correct.

A study of hysteretic characteristics would no doubt shed some light on the phenomena of magnetism, but it is beyond the scope of this paper.

DISCUSSION.

Mr. Kennelly: Mr. President. It seems to me that this paper is capable of having its results summed up after you have read it in comparatively few words. If the hysteresis loop on iron enclosed no areas, just a pair of lines immediately side by side, there would be no energy required to magnetize the iron, and the permeability of the iron would simply change as the magnetism altered. There would then have to be harmonics in the curves, but there would be no area for dissipation of energy in the iron.

Mr. Steinmetz: Mr. President. While I would like to add a few remarks to this paper, I may first express my pleasure to have listened to a paper which will not be forgotten in a year or two. The paper discusses the question whether hysteresis or permeability is the cause of the distortion in transformers. I think there is really no difference whether you assume the one or the other, because by the meaning of the word "hysteresis" you mean discrepancy between the magnetizing force and magnetic induction. I have given some instances where the distortion is not due to the hysteresis but is due strictly to varying permeability. So I think the two different opinions are not really different at all. The paper attempts to separate the effect of determining permeability into components. I am very glad that this paper has been secured to the Institute.

Mr. Charles K. Huguet: Mr. President. I would say in regard to the similarity of hysteresis and variation of permeability that I cannot quite agree with Mr. Steinmetz. If we consider the value of μ as being dependent on the ratio of the flux to the magnetizing current, then μ would be infinite at a and zero at b, both of which we know to be impossible. As a matter of fact, μ should be derived from a curve passing through zero and everywhere intermediate between the rising and descending limbs. Such a curve answers all requirements.

Mr. C. T. Rittenhouse: Mr. President. I think that Prof. Ewing in a paper presented to the International Congress held in Chicago, made the statement that permeability was decidedly distinctive from hysteresis, and that iron, which had good permeable qualities, was not necessarily good in its hysteresis qualities. Mr. Huguet has made Prof. Rowland the single exception to the permeability theory. In 1894, before the Philadelphia meeting of the Institute, I think, this very point was the subject of animated discussion between Dr. Pupin and Mr. Steinmetz, and although Dr. Pupin did not show at the time the real cause for upper harmonics he laid particular stress upon the fact that his experiments showed that upper harmonics could not be due to hysteresis. As a further remark, in reference to this paper, I would like to state that we always hear of ferro-magnetic circuit transformers, and yet I doubt if many exist at the present time in commercial practice. It seems to me that Mr. Huguet's paper does not cover all types of transformers.

Mr. Scott: It seems to me that the transformers made with lap joint magnetic circuit, approach very close to the absolutely closed magnetic circuit. If two plates of iron be brought together with a butt joint then the area between the two is equivalent to the cross-section of the plate. If the plate be 100th of an inch in thickness this may be a very small area. I agree that there is a marked difference between open circuit transformers made by Swinburne and the closed circuit transformers. I also think that there is a corresponding difference in the practical operation of those transformers.

Mr. Ries: In reference to the lapped joints of closed circuits, while it is true that lapped-joint transformers are much better in general than the open coil or butted joints, yet on the other hand from a mechanical point of view the construction becomes more difficult and the space occupied in assembling these parts is very much larger than plates which are cut out of the solid metal and placed together. In that way you get a better type. I have come to the conclusion from numerous experiments that I have conducted that that type is by far the best.

Mr. Rittenhouse: The reason I brought up the question between absolutely closed circuits was that there is a distinct difference in the action of the iron in them. There is a sticking action in which the molecules of the iron seem to form close chains. The demagnetizing force will produce an oscillation in the iron as it is demagnetized, and that is the cause of the upper harmonics. It was really this point that I wanted to bring out as showing that Mr. Huguet did not cover entirely this whole subject by stating that permeability was the real cause of upper harmonics.

[12] Transactions, vol. xi., p. 719.

Do Röntgen Rays Affect the Retina?

It is reported that Dr. Brandes of the University of Halle has found that Röntgen rays affect the retina. The experiments were based on the hypothesis that the lense of the eye is opaque to the rays, but that were they removed the retina might be affected. After performing an operation upon a patient for cataract, and removing almost entirely both lenses, the subject claimed that she perceived light upon being brought within the field of the rays.

The investigations were continued, and it was found that the rays really affect the retina of the normal eye if the head be enclosed within a covering opaque to ordinary light. This apparently was conclusively demonstrated by the facts that when a sheet of aluminum was interposed between the tube and eye the perception of light still remained, but upon interposing a plate of glass perfect darkness resulted. Experiments are being continued to ascertain whether Röntgen rays can directly affect the nervous parts of the eye or whether their action consists in rendering the retina fluorescent, thereby indirectly producing the sensation of light.

Effect of Temperature on Insulating Materials.*

BY GEO. F. SEVER, A. MONELL AND C. L. PERRY.

In designing electrical apparatus, it is often of the greatest importance to know the effect of different temperatures on the insulation to be used in its construction.

Of the many kinds of insulation, a few of the most common were chosen, *i. e.*, paper, cloth, oiled paper and oiled cloth, and the following conclusions have been drawn from the result of 102 tests on samples of materials, which were kindly furnished by several of the most prominent manufacturers of electrical machinery.

THE APPARATUS.

The heating apparatus consisted of a glass cylinder 8 inches in diameter and 10 inches high, covered at the top and bottom with

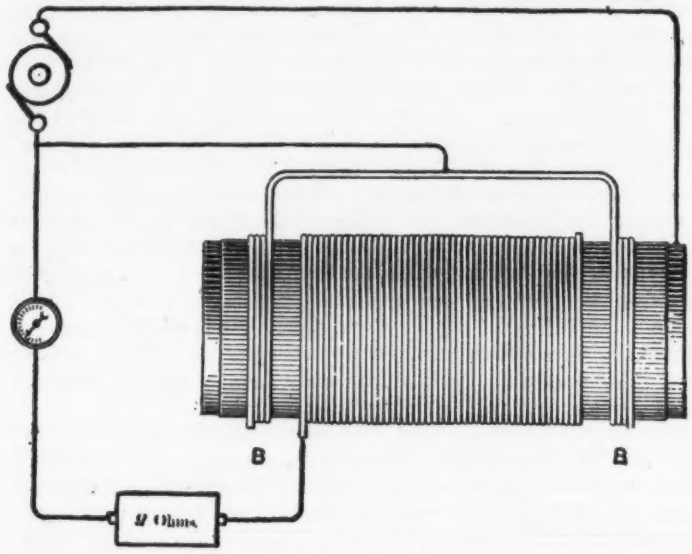


Fig. 1.

asbestos plates. The lower part of this cylinder was occupied by 12 enamel resistance tubes, 5 inches long, and 24 ohms each. The terminals of these were brought out through the asbestos plate. The current in these tubes being controlled by a rheostat, the temperature in the cylinder could be varied at pleasure. An inch above the heating tubes, and supported by an asbestos collar, was a metal plate having holes punched in it to allow the free circulation of air in the cylinder. This plate was connected to one side of a galvanometer.

The insulating material to be tested was wrapped on brass cylinders ¾ inch in diameter and three inches long, the insulation not reaching quite to the end of the tube. The insulation was then wound with No. 26 B. & S. bare copper wire for a space of 2½ inches. Five

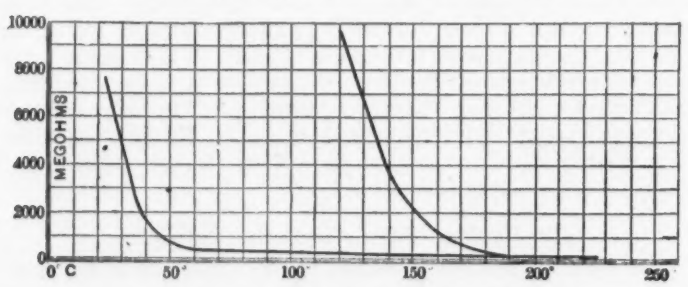


Fig. 2.—Plain Red Paper .009" Thick.

tubes so wound were then placed on the metal plate in the cylinder and their terminals brought up through the asbestos cover, and then to a switchboard, in order that any tube might be thrown into the galvanometer circuit. This arrangement made it possible to heat five specimens at one time.

With the above apparatus was used a Thomson high-resistance galvanometer, a megohm box and a difference of potential of 500 volts.

The thermometer used was of the nitrogen-filled mercurial type and capable of measuring from 0 degrees to 400 degrees C.

When troubled with surface leakage, it was eliminated in the following simple manner. The diagram shows the connections while testing a tube and also the leakage shunt.

It will be seen from the diagram, Fig. 1, that all of the current going through the galvanometer must pass from the dynamo to the brass cylinder, and thence through the insulation to coil *A* and on through the galvanometer. Any current tending to leak over the surface of the insulation from the brass cylinder to coil *A* will be intercepted and shunted past the galvanometer by coils *B B*.

During the investigation many different specimens of paper, oiled cloth, etc., varying greatly in thickness and composition, were tested, and it was found that each class has its characteristic properties strongly marked. We will now proceed to the discussion of each particular class.

PLAIN PAPER.

In this class 40 specimens were tested. After the resistance at the temperature of the air (22 degrees C.) was carefully noted, the temperature was gradually increased (100 degrees in one half hour) and readings taken every 10 degrees up to 80 degrees and from there on

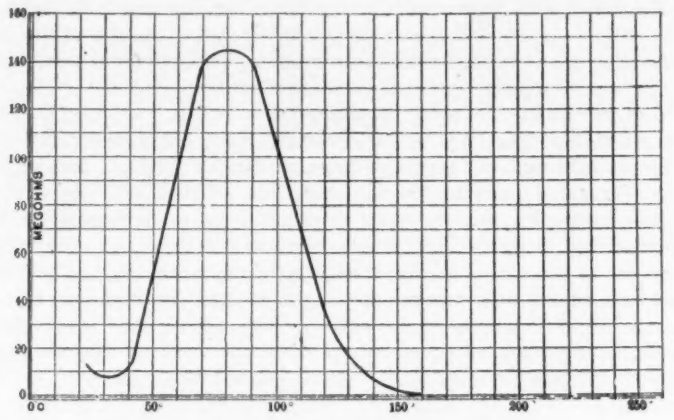


Fig. 3.—Japanned Red Paper .01" Thick.

every 20 degrees. Fig. 2 shows a curve which is characteristic of practically all kinds of plain paper.

It should be noticed, however, that in general the resistance of papers, that are not protected from moisture, falls between 22 degrees and 50 degrees, and then rises rapidly until at 75 degrees it has attained a maximum resistance. It should also be noted that this temperature of 75 degrees is very constant for all kinds of paper. From 75 degrees upward the resistance falls rapidly, and at 150 degrees is but a small fraction of its initial resistance.

The initial resistance of paper protected from moisture by japan (Fig. 3) is very high, but falls rapidly with the increase of temperature, as is the case with all material protected from moisture. (See

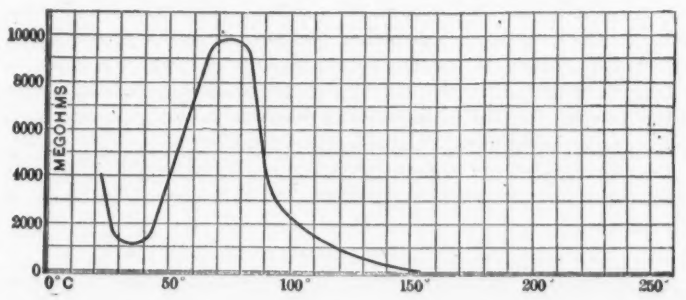


Fig. 4.—Plain Cotton Duck .015" Thick.

oiled paper and oiled cloth.) Hence we see that all paper having a porous structure, and therefore containing more moisture, has a lower initial resistance than the protected paper, but is affected by heat much less than the latter. This would lead to the conclusion that there are two phenomena taking place. First, the driving off of the moisture, which tends to increase the resistance, and secondly, some change (not a mechanical deterioration) in the material, dependent on the temperature and which may be called the temperature coefficient. This temperature coefficient tends to lower the resistance with increase of temperature.

Examining the several curves shown, we see that the initial resistance of unprotected papers is low, on account of the presence of

*A paper presented at the General Meeting of the American Institute of Electrical Engineers, New York, May 20, 1896.

moisture. Now, on gradually increasing the temperature, the resistance falls during the first 20 or 30 degrees, because the effect of the temperature coefficient predominates during this period and before the material is warm enough to start the evaporation of the moisture it contains. This, however, lasts but a short time, as the result of the evaporation is to increase the resistance very rapidly, until at 75 degrees the temperature coefficient again asserts itself and the resistance rapidly falls.

In the cast of japanned papers (Fig. 3) the initial resistance is very high, due to the absence of moisture, but on being heated the resistance drops rapidly as the small quantity of water contained is evaporated off so slowly that it has very little counteracting effect on the temperature coefficient.

Paper does not seem to deteriorate mechanically at less than 180

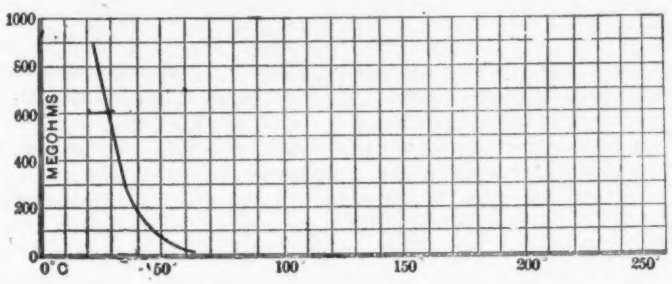


FIG. 5.—OILED PAPER .0045" THICK.

degrees; above this point the material begins to carbonize. At 230 degrees a peculiar phenomenon takes place. The material after possessing a very low resistence from 175 degrees upward, would at about 230 degrees suddenly increase greatly in resistance and immediately after break down. This may be caused by some molecular rearrangement taking place at that temperature which changes the resistance of the material. Other cases wherein the resistance of a body changes at a certain temperature are well known. In the phenomenon of "recalescence" a piece of iron or steel after having been heated to a bright redness and allowed to cool slowly, will, at a certain stage of the cooling process, receive a sudden check. Heat being generated in the metal as a result of the change, the molecular construction suffers at the critical point. The cooling is arrested and the temperature and resistance rise through the loss by radiation is still going on.

The experiments of F. Kohlrausch and Hopkinson have also shown that the critical temperature is marked by a sudden change in the coefficient which expresses the effect of temperature on the electrical resistance of iron. This is also true of nickel.

It would seem that paper insulation has a critical temperature somewhat analogous to that of iron, steel and nickel, but of course the characteristics of the materials are too different for any close similarity.

PLAIN CLOTH.

Under this head 20 specimens were tested including canvas, linen and muslin, of different thicknesses. The action of this material (Fig. 4) is much the same as that of paper (Fig. 2). The initial resistance is lower as it contains more moisture than is the case with paper; for the same reason when the moisture evaporates off, the increase over the initial resistance is greater than with paper. By reference to the curves of paper and cloth it will be noticed that their resistance varies in the same manner. For cloth, as for paper, the maximum resistance is at 75 degrees C. The material does not begin to carbonize until at a temperature of 180 degrees C. and even beyond that point it loses its mechanical strength very slowly until past 220 degrees.

The explanation for the resistance of cloth varying as it does is exactly similar to that for paper.

OILED PAPER.

In this class 14 tests were made, on papers of different thicknesses. With the single exception of one specimen (the resistance of which was very high) the initial resistance was lower than in the case of paper. (Compare Figs. 2 and 5.)

On increasing the temperature the resistance fell rapidly, the curve being much the same as that for japanned paper. The reason for the sudden decrease in resistance is the same as that for japanned paper.

Oiled paper deteriorates mechanically at a lower temperature than paper or cloth, commencing to blacken at so low a temperature as 120 degrees C.

OILED CLOTH.

In this class 28 specimens of oiled silk, muslin and linen of various thicknesses were tested. The initial resistance of this material is much lower than that of paper, and on increasing the temperature the resistance falls rapidly, the shape of the curve (Fig. 6) corresponding to those of japanned and oiled paper. The reason for the sudden decrease in resistance undoubtedly being the same as for the japanned and oiled paper. The insulation begins to char at about 120 degrees C.

GENERAL CONCLUSIONS.

In the foregoing discussion there are some main points to which it is necessary to draw attention. These are:

(*a*) That paper is a better insulation and withstands increase in temperature much better than cloth (shellac and varnish were not used in any of the experiments), oiled paper or oiled cloth.

(*b*) That paper and cloth have a maximum resistance when first heated at about 75° C. and are not injured mechanically under 180° C.

(*c*) That the point of maximum resistance for paper and cloth (in this case 75° C.) depends on the rapidity with which the temperature is increased.

Here the authors would like to suggest that if the material were kept at a constant temperature until all the moisture had been evaporated, the resistance of the material would then be a *true* resistance at that temperature.

(*d*) That all give a high resistance after cooling, but have little mechanical strength.

Oiled paper and oiled cloth, however, after having been heated to 220° C. and allowed to cool, not only have a high resistance, but became so firmly fixed to the brass cylinders that it was found necessary to remove them with a file.

(*e*) That it would be well to bake paper and cloth insulation to 140 degrees C. before applying varnish or shellac.

(*f*) Referring to Fig. 3, it will be seen that on decreasing the temperature the resistance increased, but the second curve does not by any means coincide with the first. On further experimenting in this direction, it was found that there is no temperature at which the curve with falling temperatures coincides with the first. This may

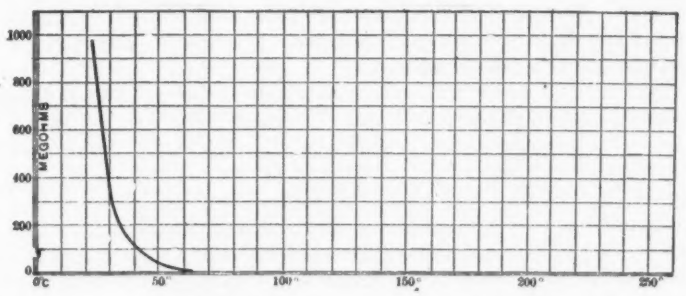


FIG. 6.—OILED SILK .007" THICK.

be due to more moisture being driven out at higher temperatures which is not absorbed by cooling.

Here it may be well to mention an interesting phenomenon that occurred in connection with this investigation.

When the temperature has risen above 100 degrees C., the zinc in the brass cylinder begins to leave its surface and combine with the copper wire wrapped about the insulation so that the wire has a brass surface and the brass cylinder a copper surface.

Owing to the limited time at the authors' disposal, they were unable to further pursue this investigation, but much remains, and any research along this line will be found full of theoretical as well as practical interest.

DISCUSSION.

Mr. Steinmetz: While this paper is very interesting, I think some misleading and dangerous conclusions may be drawn from it, namely, the value of different insulating materials. The paper shows that dry fibre is superior in insulating qualities to oil-paper or oil-cloth. While this is undoubtedly true, it has frequently been observed that dry fibre has very high insulating resistance, and that consequently the insulating resistance is decreased by treating the paper with oil or japanning it. Very high insulating resistance, too, is not the only condition to be looked after in a proper insulating material.

Prof. F. B. Crocker: I agree that the paper standing alone might give rise to the dangerous conclusions of which Mr. Steinmetz has complained, but it was intended simply to investigate this particular fact, as the paper clearly shows if carefully read. Investigations were carried on several years ago showing the effect of moisture on these various materials, and also showing their disruptive strength. It would, of course, be proper to put these all together, and a proper comparison would include all of these qualities, due weight being given to each, but it is surprising—and I think is not generally known—that the effect of oil is to actually diminish the insulating qualities, particularly as soon as the temperature rises. Comparing these curves we find that even as low a temperature as 50 degrees C. causes the oil-paper and cloth to fall to a very low value, whereas the plain paper and plain cloth have their maximum insulating resistance, which is a very high value, at 75 degrees C. That certainly is very striking and well worth noting. I should also call attention to the fact that probably on the continued application of any of these temperatures there is a greater effect than the comparatively limited application of temperature which was the occasion of these experiments. Therefore, I should expect, simply to judge from these results here, that 50 or 60 degrees C. applied for a long time to oil paper or oil cloth would bring their insulating resistance down to such a low value that they would be in danger of being broken down. I think that would explain a great many of the gradual burn-outs that occur in electrical machinery, and it remains to be seen by practical experience what the actual facts are. I know I was very much surprised when I saw the results. They must necessarily have a proper importance and application. I agree fully with Mr. Steinmetz that the insulation resistance is by no means the only point to be considered. Nevertheless, it is an essential. Now, if these materials do have a very low resistance at such a moderate temperature as 50 or 60 degrees C., it would imply that they are not suited to work continually at that point, 60 degrees C. would not be considered high. Exactly what is the best thing to do is not, of course, the intention of this paper to show, but it would indicate that we ought at least to consider this point, and that if the machines are to be worked at a high temperature we should consider whether oil is a desirable thing to have. In regard to the effect of moisture, that only applies to the starting up of the machine because when the machine gets working that objection disappears. I might add that the tension used in these tests was 500 volts, while not a very high potential is sufficient to show up any very great weakness in disruptive strength.

Mr. Scott: I think it is well to put some safeguards and danger signals about a paper of this kind, for taken directly on its face it is apt to lead to erroneous conclusions. I am familiar with quite a number of tests made by Mr. Skinner, of the company with which I am connected, on very much the same lines. In his tests he has taken larger pieces of insulating material and placed them between two pieces of iron which have been heated up at a slow rate, and the insulating resistance of the material has been measured from time to time. The law which he has determined, if expressed on, say, curve 2, of the present paper, has its minimum where this curve has its maximum. That is, in Mr. Skinner's test there is a certain initial resistance which decreases to a minimum at 75 to 100 degrees, and after that increases. The tests to which I refer were made under what were presumed to be fairly commercial conditions in the manufacture of machines for the purpose of determining just what could be expected at different temperatures of different insulating material. Quite a large number of materials were tested, covering about the range and kind reported in the paper. Now, either those results were wrong or these results are wrong, or they were made under different conditions. I am not prepared at this moment to say which of these may be true. I do know that in the tests with which I am familiar, extending over a considerable time, and made in some cases on the machines themselves, the resistance of a a new machine after successive runs, as the armature or field became warmer and warmer, and also on individual pieces of different kinds of material, the same general characteristics were found in the different tests, disagreeing with those given in this paper.

The subject of oil is mentioned in the paper, and one feature which may explain the rapid decrease in the resistance of the oil paper may be due to this fact. If there be some moisture in the paper itself and the surface be covered with a film of oil the moisture will be confined until the temperature is raised, and then it will be vaporized and try to escape. If the surface be nearly continuous it may contain some openings in the oil. The water will force itself out at certain points; it will pass from a hotter place to a cooler place, and the tendency will be to collect the water at some one point. The moisture in accumulating in this way may decrease the resistance very much at one point. Nothing is said in the paper as to the kind of oil used. There are different grades of oil, differing widely in their resistance, and often containing impurities, which may decrease the resistance very much. In the case of some oils the resistance may be comparatively low. If the oil be heated up and then cooled it may be considerably higher, possibly the moisture or impurities in the oil being driven off. The general conclusions may be justified from experiments which have been performed, but these, as have already been stated, cover a small range, and it is going too far to draw conclusions which are general from so limited data. For instance, the first conclusion, that paper is a better insulation and stands increased temperature better than cloth. Better for some things, perhaps, but not to be put in a dynamo. A high resistance galvanometer and rapid measurements are dangerous things often in practical machinery. Some results of that kind might well have be incorporated in the paper. Another conclusion of the paper is that it would be well to bake the cloth, etc., before applying shellac and varnish. I fail to see the curve or data from which that conclusion is drawn, and I do not understand why that temperature, instead of some other or possibly lower temperature, or lower temperature continued for a longer time, may not be a preferable one. I notice on the last page of the paper the statement that when the temperature has risen above 100 degrees C. there seems to be some transfer in the metals which are surrounding the insulating material. It appears from that that the zinc passes from the cylinder through to the wire. If it does, that may have a very decided effect upon the insulation or the medium between the two. If there is electrostatic action, or something similar to that, by which the metal is passed through the insulating material from one side to the other, the phenomena there may be very important as well as interesting. The subject is an interesting one, and I call attention to the several points in this way in order to provoke discussion and prevent any wrong conclusion.

Prof. Crocker: In the first place I think Mr. Scott should give up the form of that curve. We have a minimum point here at about 35 degrees C., and we have a maximum point at about 75 degrees. Then it falls again. If we shift that curve one side or the other then that would fully explain the simple statement that Mr. Scott makes. That may not be sufficient, but so far as anything he said is concerned that would fully explain the difference. If Mr. Scott remembers the form of those curves, I would suggest that he state them, and the temperatures corresponding, otherwise it simply brings confusion without adding much to our knowledge of the subject. In regard to the limited range of these curves, as a matter of fact there were 102 tests made. I think it is very seldom that the institute has a paper presented to it which is the result of so many tests as that. I imagine that papers have been read here which were the result of only one test. In regard to the oil paper and oil cloth, I would say that 14 tests were made on the former, and 28 on the latter, and they were made on material furnished to us by all the prominent manufacturers in the country. In other words, we took insulating material as we found it. The tests were made entirely without favor. The surprising fact was the uniformity or general similarity that was shown by the different samples of the same class of materials. In regard to the zinc phenomena, that was observed a year ago, and, while I did not intend to make this statement, as I would prefer to verify it a little more fully, apparently zinc is found at quite a low temperature. A very small amount of zinc paper goes into this receiver, and if you put a piece of copper in the same receiver and heat them up to, say, 200 degrees C., we actually find that the change I have referred to does take place, and chemical analysis proves it. That is a very startling statement perhaps, but, after all, it is not entirely dissimilar from other visible facts that are known. Water has a vapor tension away down to absolute zero, and ice evaporates. It is by no means necessary to have the temperature at 210 degrees in order to have water vapor present. It has a vapor tension at any temperature even as low as zero. Therefore, we might reason by analogy that the zinc also has vapor tension, and there is a certain amount of zinc present in a space at a comparatively low temperature. It seems to me that the analogy is not, of course, too far, and it is only necessary to have a small amount of zinc present in that place at any given moment for this transfer to slowly occur, and during that time a superficial deposit of zinc is produced. We intended to carry it further before making a positive announcement on the subject, but it crept into this paper somewhat accidentally.

Mr. Scott: The form of the curve to which I referred is in general a uniform decrease from ordinary temperature until a temperature about a boiling point is reached, the resistance falling off fairly uniformly, and after that increasing, making a fairly smooth curve at the point of minimum resistance. After that time the resistance is under a temperature of say 125 degrees to 150 degrees C., as I recollect the curve. There was no falling off—at any rate, no falling off so marked as that shown here in the paper. The first dip in the curve as presented in the paper, as seen in Fig. 2, seems to indicate the presence of moisture which is driven off, that moisture being driven off at about 40 or 50 degrees C. If that lowering of the grade is due to the driving off of moisture, the driving off has occurred much sooner and at a lower temperature in the curves here than in the curves to which I referred. That may be due to the condition of the apparatus. In the tests described in the paper the specimens are small in amount and entirely surrounded by warm air, and have great facility for throwing off moisture. In the tests to which I referred the material was more confined—more as it is in the insulating machine—and the moisture does not have as great facility for passing away. The special tests and the materials were made on somewhat the same conditions. The iron plates were six or eight inches in diameter, so that the insulating material in between was fairly well defined. At 150 degrees the resistance is at its lowest point. In the other work to which I referred the resistance at that temperature was as high or higher than it was in the beginning of the test.

I draw attention again to the statement I made before, that although there are many tests here in number they do not cover a very wide range in condition, and yet some rather broad general conclusion are drawn from the paper. With regard to the transfer of zinc, I inferred from the paragraph in the paper that the zinc left the cylinder under the insulating material. If it did not, if it was volatized from the ends or interior of the cylinder, or some other part, then that phenomena is disposed of.

Mr. Kennelly: I think if we appreciate the character of this paper, which is a very interesting and instructive one, we are not likely to form any unfair or unwarranted conclusions from the results which it shows. The subject matter is essentially a practical one, and only can be dealt with it seems to me from a practical point of view. The samples before us represent cellulose in a certain condition, containing certain additional materials of a coloring nature, and also additional materials of an oleaginous or varnish nature. It is also impossible to state what the specific resistance of such a material should be, except under so many incidental conditions as to render the result when stated of very little practical importance. The material is fibrous, loose in character, and the structure is capable of absorbing an enormous volume of gas or even of liquid, and the conditions under which it is employed in practice are such that only those conditions are of any importance in the paper. The resistance of thin films of this substance is given in the curves before us under certain practical conditions. The material contains water. Those of us who have experimented with condensers know how difficult it is to free paper entirely from the last trace of moisture. It has an absorptive power for moisture in the atmosphere which is only equaled by the tenacity by which ammonia will be absorbed by water.

Mr. Steinmetz: It appears to me, Mr. President, that one source of possible error has been overlooked in the paper, and that is chemical action. Most of the varnishes are compounds of organic acids, which are acted upon, and which act upon copper and espicially zinc. It is quite possible that the varnish has been acted upon by the zinc.

A New Use of Telegraph Poles and Wires.

Cutting telegraph wires is, according to Mr. R. V. Luke, of the British-Indian Chitral Expedition, a favorite amusement with frontier tribes. They find the wire useful. Sometimes, too, they convert the hollow iron posts of which the telegraph poles are made into guns by lapping them round with wire; and they cut the wire up for bullets.—*Popular Science Monthly.*

A Compliment to the Institute.

In a brief editorial article on the Institution of Electrical Engineers (of England) the London *Electrical Review* makes the following remarks: "The American Institute of Electrical Engineers—a much smaller body, with smaller funds—appears to do much, very much, better work and more of it. Perhaps the comparative youth of its Council is the explanation."

The Reconstruction of the Plant of the Chicago Board of Trade.*

BY BION J. ARNOLD.

The writer believes that all the energy required to produce motion and light in an office building should be developed in one set of steam engine cylinders and on one generator. This set of cylinders, together with the working parts of the engine and its generator connected directly to it, constitute the unit which produces the energy of the plant, and this unit should be made to work at its maximum economical load throughout its entire period of operation, while the energy from the unit should all be utilized during its running time.

The operation of the electric elevators has been for four months on an average consumption of 4¼ kw-hours per car-mile, and as the duty required of them is conceptionally heavy, and the cars very large, this showing is very satisfactory.

The general plan of the plant is as follows:

Referring to Fig. 1, which represents the basement of the Chicago Board of Trade, the relative location of the different machines which enter into the plant can be determined. It will be seen that the installation consists of the following:—Five 66 x 16-foot horizontal

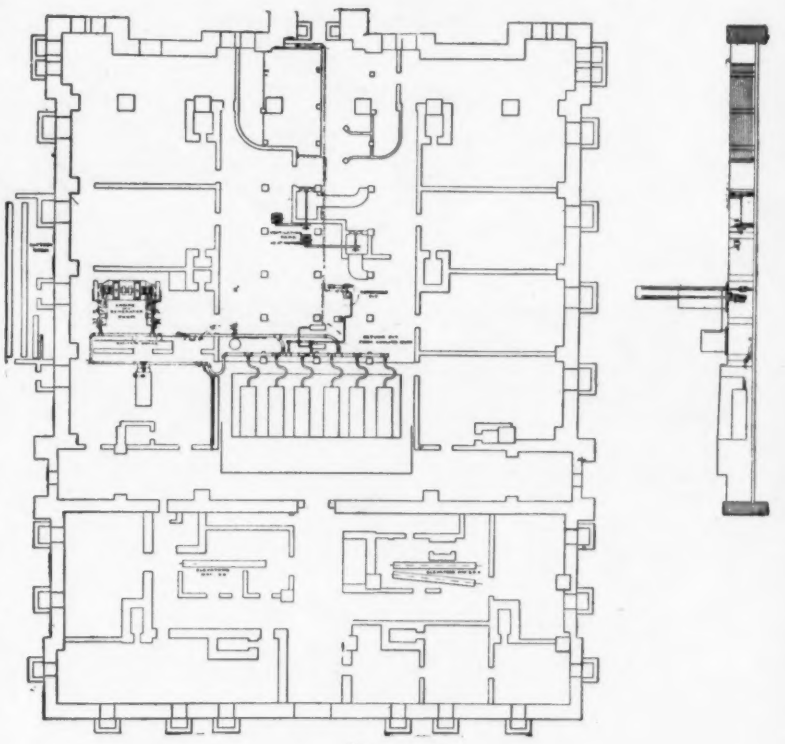


FIG. 1.

tubular boilers, designed to carry 125 pounds pressure per square inch; two 150-hp horizontal compound condensing engines running at 275 revolutions per minute, each directly connected to a 75-kw direct-current generator, under a special system devised by the writer, and hereinafter described, which permits of either or both generators being driven from either engine. Four horizontal 30-hp multiple sheave elevators; six 10-hp electric motors, five of which operate ventilating fans, and one the machinery in the machine shop. There are also 65 1600-ampere-hour storage cells, and the necessary switchboard and connections for the handling of the above machinery, all of which is more distinctly described hereafter.

Fig. 2 represents diagrammatically the main leads or copper conductors of the building, used for the operation of the above-described electrical machinery. The general plan is clearly shown by the diagram, and this system was adopted owing to the fact that the building was so constructed that two main flues or passageways extending from the basement to the attic in opposite portions of the building, and near its centres, were available for carrying the main risers. It was decided to place in these passageways vertical risers of sufficient carrying capacity to carry the total amount of energy required for the nine floors, and to join the floor leads or secondary mains until each of these risers are at their ends. With this arrangement it was possible to feed the secondary mains at two independent points, thus equalizing the pressure to better advantage and making

* Abstract from a paper presented at the General Meeting of the American Institute of Electrical Engineers, New York, May 20, 1896.

the plant more reliable in operation. From the centre of these vertical risers, or at about the fifth floor, the main leads drop from each shaft, thence extend horizontally on the ceiling of the basement to the switchboard. Each of these mains which lead to the centre of distribution in each shaft are of sufficient carrying capacity to carry the total load of the building, exclusive of the basement, consequently if a fuse blows on either one of the mains, or if by any

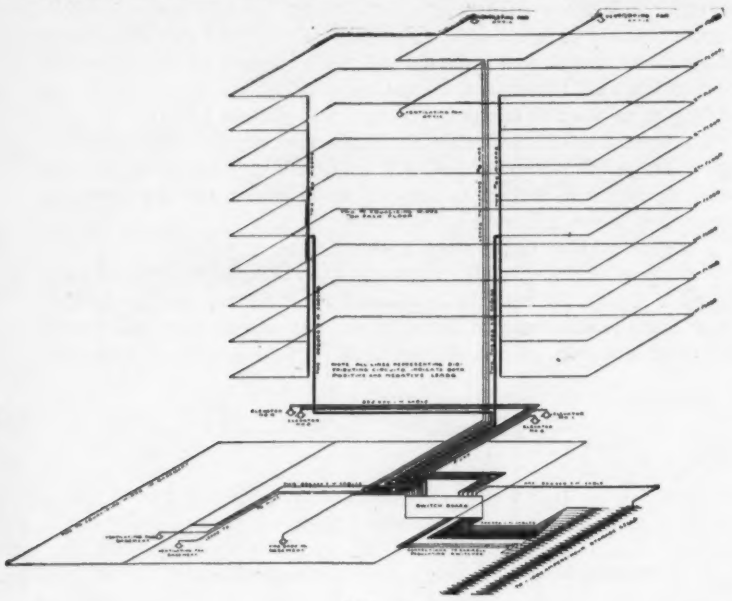


Fig. 2.

accident one of the mains should become broken or opened, the other main will carry the necessary current to keep the lights operating in the building.

The basement circuit is independent of the above described mains, and consists of positive and negative leads, surrounding the entire basement of the building, from which are tapped the arc and incandescent lights used in the basement. The motor circuits are closely indicated in the diagram, and are independent of the lighting circuits, and are so planned that the starting rheostats of the motors are connected on the switchboard under the control of the engineer, thus making it possible for the engineer to start or stop any motor in the building without leaving the switchboard. The elevator circuits are also independent of the lighting and motor circuits, and it is possible to throw the current on or off any elevator at the switchboard. The batteries are located in a room adjoining the main engine room, and connected with the switchboard, as shown on the diagram.

The losses in wiring circuits of the building are computed as follows: Between generator and switchboard, one half of 1 per cent.; between switchboard and centre of distribution, 2½ per cent.; from centre of distribution to secondary mains, 1 per cent.; between secondary mains and lights, 1 per cent., making the total loss between generator terminals and lights 5 per cent.

Fig. 3 represents largely diagrammatically the switchboard of the plant. From this it will be noticed that the plant is designed for three generators, but two of which are now in operation, as they are sufficient for the work. The lighting bus-bars carry the main lighting circuits, controlled by switches 7, 8 and 9, and also the motor circuits controlled by switches 1, 2, 3, 4, 5 and 6. In the main lighting bus-bar is placed the recording wattmeter, which registers all the energy delivered from the generator to the light and motor portions of the plant. In the elevator bus-bars is placed another recording wattmeter, which registers all the energy delivered to the elevators from the lighting bus-bars. With this arrangement and the means available in the plant for measuring the amount of coal and water consumed, the operators are enabled to keep accurate daily records of the cost per kilowatt of the energy produced and delivered by the plant. The diagram of the switchboard clearly shows the windings of the different generators and motors, and need not be further explained.

The generators are connected to the board by means of two switches, one of which is a triple-pole double-throw switch, and is arranged so that when thrown into the upper position it connects the generator to the elevator bus-bar, using the compound winding of the generators. This arrangement permits the generator to operate the elevators and take care of the variable load without the use of the batteries. When the same switch, for instance No. 13 or 15 on the accompanying diagram, is thrown in its lower portion, the circuits are so arranged that the compound or series winding of the generator is cut out, and the equalizer connection from the generator becomes the positive connection, and the generator is connected to the elevator bus-bar's shunt wound, thus eliminating its series winding. With this arrangement, the generators and the batteries are run in multiple on the elevator load.

Referring now to the right-hand part of the board which is the storage battery proper, the operation is as follows: Under normal conditions, any elevator is operated shunt wound in parallel with the batteries by closing its corresponding switch, as, for instance, switch 15 for dynamo No. 3, downward the 15 *b* position. By closing switch 17 to 17 *a* position, the current passes from the positive elevator bus-bar to the hand regulating cell switch, and out to cell No. 16, when the regulator is placed as shown on the diagram. From cell 16 the current passes through the series of cells coming out at the negative

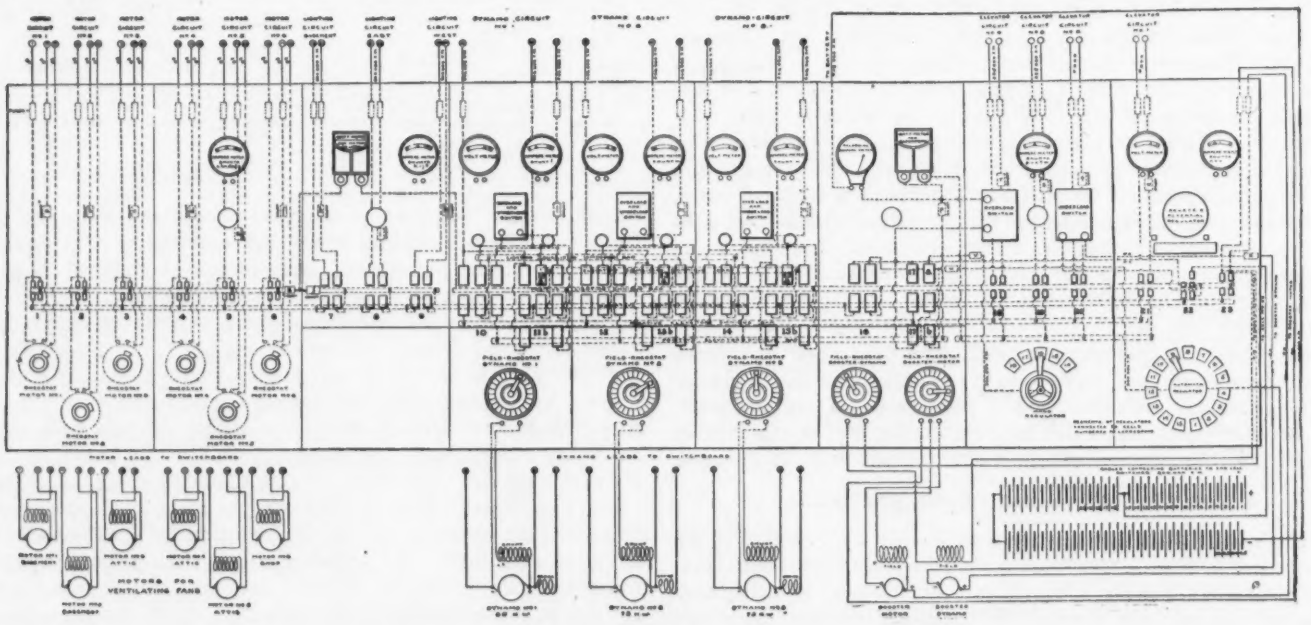


Fig. 3.

end, thence through the proper conductor to the recording ammeter, thence to the overload switch and down to the negative terminal of switch No. 17 *a*. It will now be seen that whatever number of batteries are being operated in this series, are in parallel with the generator. The hand regulator is placed in the position indicated to enable the operator to cut in a sufficient number of cells in parallel with the

generator, so that the cells will be constantly charging during the time of operation of the elevators, except at the temporary moments of overload caused by an excessive demand for current by the elevators. When this pull from the elevator occurs, the batteries respond and take the surplus load from the generator. With this arrangement about 50 of the cells will be kept constantly charged, and in parallel with the elevators. In case the amount of current entering the cells is excessive between the intervals of heavy load on the elevators, the hand regulator is adjusted so as to cut in one or more cells until the current becomes reduced to the proper amount for the batteries; and, on the other hand, if the amount entering the cells is not enough to keep them properly charged, the hand regulator is adjusted so as to cut out a number of cells until the proper amount of current is reached. In the meantime, if the 15 end cells require charging, they are charged by means of the independent booster or motor generator in the manner hereinafter described. All the batteries can be operated in parallel with the generators when running shunt-wound in the same manner as they are fused in conjunction with the elevator bus-bars, by closing switch 17 downward to position 17 *b*. The connections for same can be easily followed on the diagram.

In order to operate the batteries in parallel with both the lighting and the elevator bus-bars at the same time and maintain a practically constant voltage on the lighting bus-bars, it is necessary to operate the generators shunt-wound instead of compound-wound. As before shown, the switches are so arranged that the compound winding of the generators can be utilized when the batteries are not in service, and the shunt winding used when the batteries are being run in parallel with the elevators and lights. Therefore, to maintain a practically constant voltage on the lighting bus-bars and to run the elevators in parallel with the batteries at the same time, the operation is as follows:—Switch 17 *a* is closed upward and operates as previously described in conjunction with the elevators and batteries. Switches 10, 12 and 14 are open to prevent the generators operating compound-wound on the lighting bus-bars. Switch 16 is closed and the current passes as follows: From the positive elevator bus-bar through the switch 17 *a* to the centre of the hand regulating switch, thence through the connection from the hand regulating switch to the corresponding cell (shown on the drawing as cell 16) thence through the series of 49 cells, out through the negative end and its corresponding connection, through the recording ammeter and overload switch, to the negative side of switch 17 *a*, thence to the negative elevator bus-bar. It should be borne in mind that the lighting bus-bars and the elevator bus-bars are operating at different potentials, and that the potential on the elevator bus-bars is changing slightly with the change of load, caused by variable load on the elevators. When the demand for current from the cells is great, as for instance when the elevator load is severe, the E. M. F. of the number of cells in parallel with the elevators necessarily drops, consequently the E. M. F. of the number of cells in parallel with the lighting bars, which includes all the cells working with the elevators, and a few of the regulating cells, would correspondingly drop, and some means must be provided to hold up the voltage of the lighting bus-bars. This is accomplished by means of the automatic regulator, which is controlled by a solenoid switch, shown in the upper right-hand portion of the diagram. This solenoid switch operates by means of suitable connections to the lighting bus-bars, in such a manner as to make and break the circuit through mercury cups as follows: When the voltage of the lighting bus-bars is reduced slightly, one side of the field of a right and left-hand motor is thrown in, which causes the arm of the automatic regulator to move clock-wise, thus cutting in more cells in parallel with the lighting bus-bars and holding the E. M. F. up. When the E. M. F. of the lighting bus-bars reaches its proper voltage and tends to exceed it, the solenoid acts in the opposite direction and cuts in the left-hand field of the automatic-regulator motor, and brings the left-hand field into service, causing the automatic regulator to rotate contra-clock-wise, thus cutting out cells until the voltage reaches the desired point. By this means a constant E. M. F. is maintained on the lighting bus-bars, and the cells are worked in parallel with both the lighting and elevator bus-bars.

(*To be continued.*)

Influence of Electricity on Bacteria.

In a communication to the Paris Académie des Sciences, M. Lortet states that, according to experiments made by himself, active bacilli are sensitive to the action of an alternating current, and arrange themselves parallel to its direction.

At the Electrical Exposition.

Interest in the Electrical Exposition continues unabated, and large and enthusiastic crowds gather afternoon and evening to admire and study the attractive exhibits, which exemplify the diversity of applications of electricity. The exposition has undoubtedly done much good in an educational way. Schools and classes from the city and near-by places have visited the hall in separate bodies at different times to study its features; the object lessons afforded on this occasion are rarely available at one place and time, and the heads of various institutions of learning, appre-

ILLUMINATING SPRAGUE SIGN WITH 220 VOLT LAMPS.

ciating the valuable opportunity thus afforded for study, were not slow in embracing it.

We give this week illustrations of several of the prominent exhibits, together with a brief description of the same. These and other exhibits have already been described in previous issues of THE ELECTRICAL WORLD.

THE ELECTRIC ARC LIGHT COMPANY is shown to good advantage in an accompanying illustration. This company is a New York concern

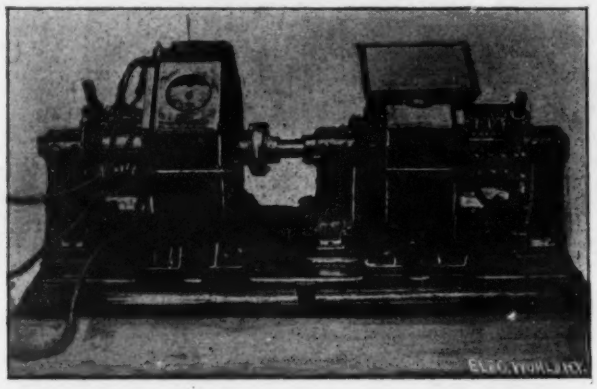
EXHIBIT OF THE ELECTRIC ARC LIGHT COMPANY.

and is successfully introducing its enclosed arc-lamps. The advantages of the "Pioneer" lamp are long life of the carbons, steady and evenly distributed light, there being no shadows cast. The company had several of its lamps in use in various exhibits throughout the hall.

THE SPRAGUE ELECTRIC ELEVATOR COMPANY'S sign at the Exposition was brilliantly illuminated by 12 Bryan-Marsh 220-volt, 16-cp Imperial lamps. The Bryan-Marsh 220-volt lamps have been installed in several

Siemens & Halske plants in the Northwest, in competition with the three-wire system. It will be remembered that Mr. W. N. Stewart read a paper before the recent meeting of the Northwestern Electrical Association regarding 220 lamps, which paper aroused considerable discussion. Mr. Stewart contracted for the installation of the plants above referred to.

The H. W. Johns Manufacturing Company has on exhibition in the space of the Edison Electric Illuminating Company a heating pad or



Tandem Transformer, Crocker-Wheeler Exhibit.

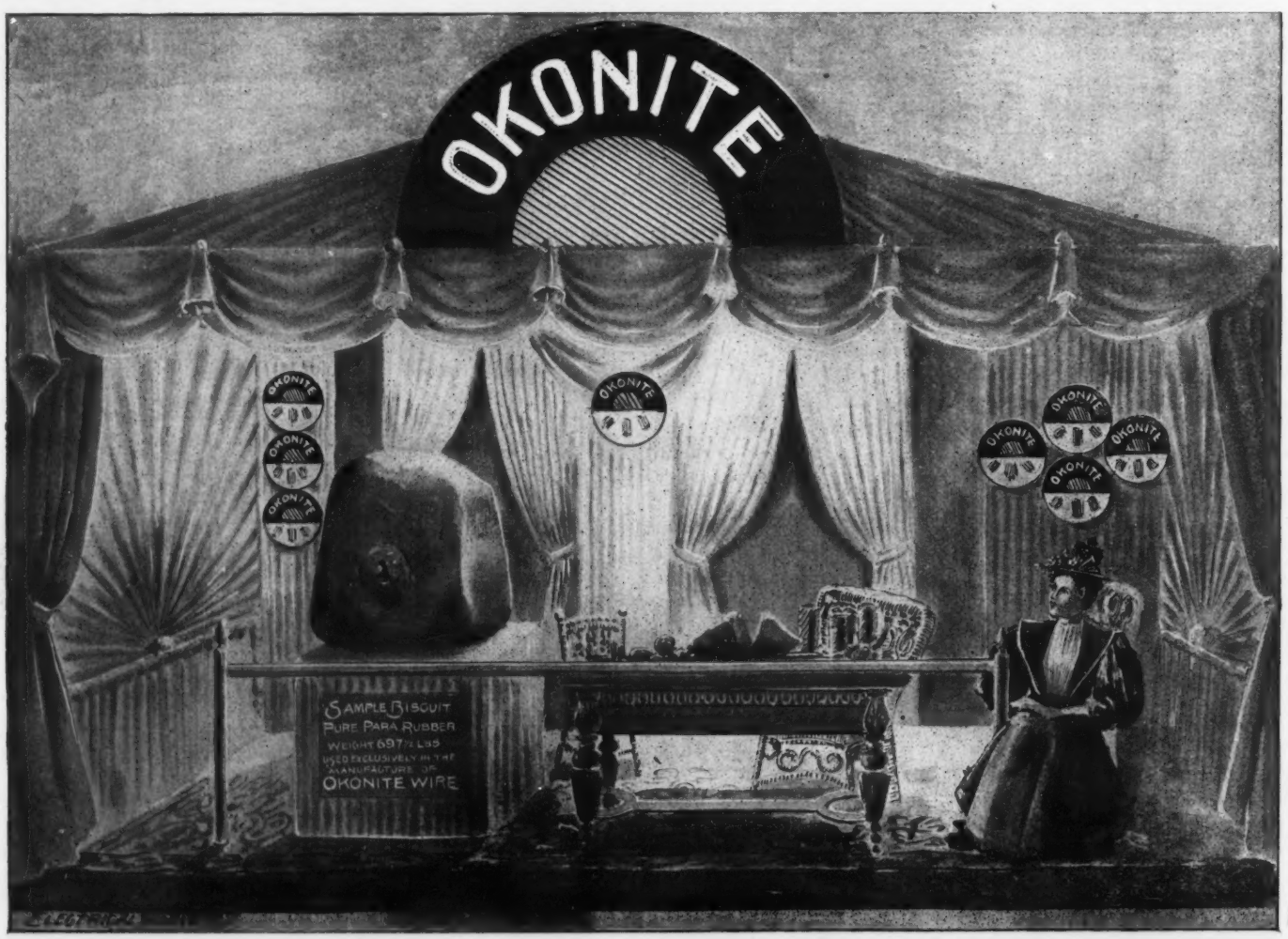
Electrotherm, which is intended to take the place of the ordinary methods for making ordinary and local applications of heat in such sicknesses as rheumatism, pneumonia, etc., where constant temperatures may be desirable or necessary. This device was described and illustrated in The Electrical World of April 11, 1896. The pad consists of a fine resistance wire wound with asbestos cord, which is woven into a mat or sheet with an asbestos woof. A flexible cord and plug are attached for connection with the ordinary incandescent lamp socket or service tap. A regulating socket is also provided, whereby the temperature of the pad may be confined to three different degrees of intensity, varying from 100 to 250 degrees, depending upon circumstances. The principle of the Electrotherm has been applied on a large scale in the manufacture of street-car heaters, which the H. W. Johns Manufacturing Company is now introducing on many electric railways.

The Crocker-Wheeler Electric Company's exhibit occupies a prominent location in the main hall, the space being open on all four sides. The exhibit is an attractive one, and the firm name is proclaimed on an artistically designed electric sign. Among the features are some of the largest machines ever produced by this company, and a direct-connected generating set—comprising engine and dynamo. The method of winding armatures is practically illustrated, and the process has a fascination

Crocker-Wheeler Exhibit.

for the uninitiated. Many other things of interest are shown by the Crocker-Wheeler Company, whose exhibit was described in fuller detail in The Electrical World of May 16.

The Okonite Company, New York, is represented at the Exhibition not so much by what it shows as by that cordiality for which the gentlemen connected with the company are well known. Yet there is considerable shown, too, in the artistic arrangement of the booth which occupies a prominent position under the western gallery on the main floor. The decorations of the space are rich and extremely attractive, and the easy chairs afford luxurious rest to the tired visitor. The most prominent object in the booth, and one which would seem to be not of place amid such surroundings, is an immense mass of crude rubber resting on a box, weighing no less than 697 pounds. Samples of Okonite wire were also shown.



The Okonite Company's Booth.

THE GOUBERT MANUFACTURING COMPANY, New York, has a fine exhibit located directly opposite the various exhibits of power. The specialties which the company makes are too well known to need special mention. The Stratton separator is the pioneer in the art of producing dry steam, and is coming to be a standard piece of apparatus in many steam plants. The Goubert feed-water heater is shown in section by means of a small model. Its free exhaust, durability and arrangement for ready cleaning

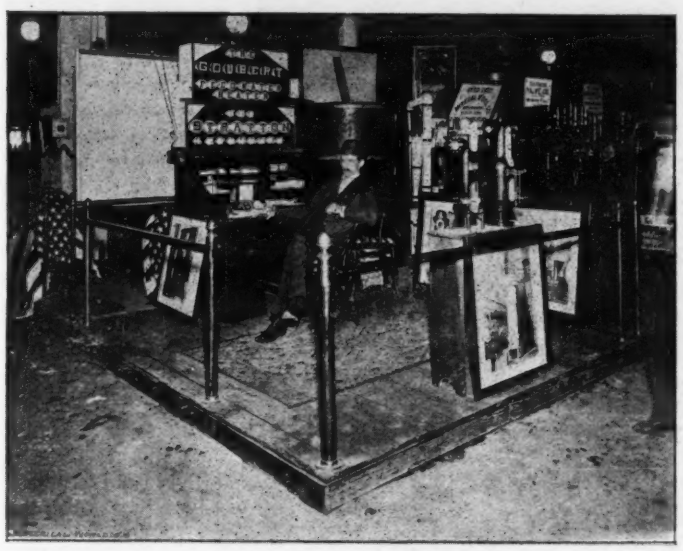
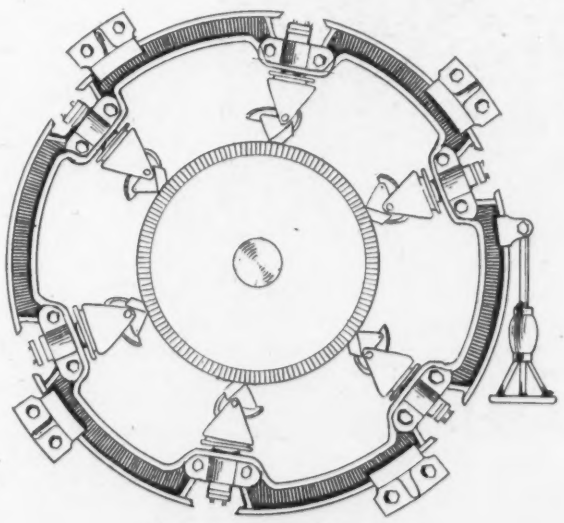


EXHIBIT OF THE GOUBERT MANUFACTURING COMPANY.

have always made it a favorite, and able gentlemen in charge explain its working and its merits to such as have not yet become conversant with them. The booth is prettily decorated, and the name of the company, together with the goods it handles, are displayed by means of electrically illuminated transparent letters. The accompanying illustration gives a general idea of the exhibit, which is typical of those of the Goubert Manufacturing Company whenever it has had occasion to thus display its goods.

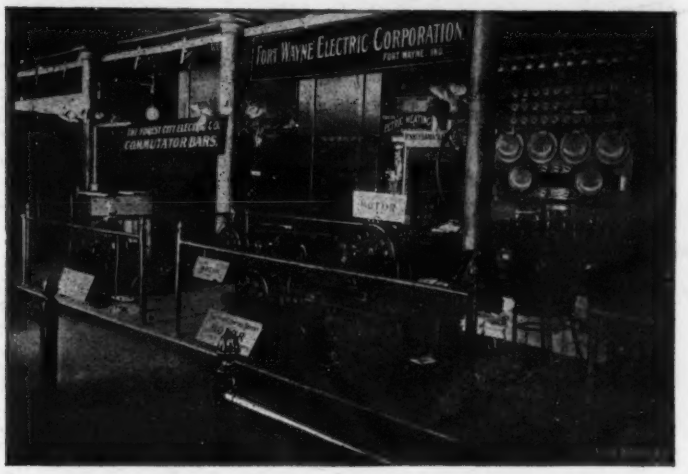
THE WALKER BRUSH-HOLDER.—A new and ingenious brush-holder recently brought out by the Walker Company, Cleveland, O., forms the subject of the accompanying illustrations, from which its general features of construction will be readily seen. The dynamo can rotate in either direction, and it is always revolved against the brushes. A spring in the rear gives any desired tension on the brush, by a single adjusting motion. The first impression on looking at this brush-holder is that the brushes are very insecure, but experience demonstrates otherwise. At the National Electrical Exposition a Walker dynamo is running with these brush-holders, and its performance attracts a great deal of attention. The commutator is purposely adjusted to run out of true, and the brushes play up and down and neither spark nor shake loose. On brushes so placed that gravity does not tend to make them fall out the finger may be lifted from the top of the brush and it will neither jar out nor spark. The finger, it will be seen, presses the brush firmly against the flat surface



WALKER BRUSH-HOLDERS.

of the holder making firm contact. As the holder is always tightly clamped to its stud with set screws, contact therewith is secure and sufficient, and the current may be taken directly from the support without special cables. The success of this brush has caused the Walker Company to adopt it on many of the numerous types of dynamos it is producing.

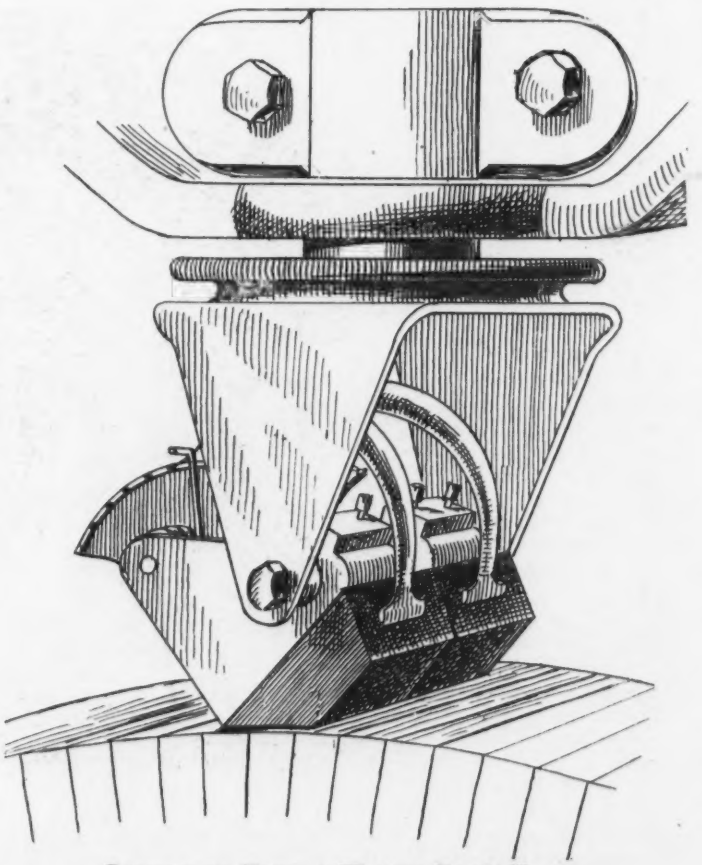
THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., is distributing a novel and attractive souvenir entitled "A Reminder of Ohm's Law." It is eagerly sought, and must be seen to be appreciated. It impresses on the mind of every one who sees it the most essential primary law of the science. It can be secured at the company's exhibit or by writing or calling at the nearest office of the company. Samples of the company's standard makes of lead-covered cables, the catalogue and descriptive lists attract considerable attention and are in great demand.



FORT WAYNE ELECTRIC CORPORATION EXHIBIT.

The company is well represented by Manager G. L. Wiley, A. B. Saurman and Edward Sullivan, of New York. Mr. J. W. Marsh, the vice-president and general manager of the company, has also been in attendance.

THE FORT WAYNE ELECTRIC CORPORATION, Fort Wayne, Ind., makes a fine display of its well-known apparatus, and an illustration of the same is presented herewith. One of the features of this exhibit is the rotary transformer which receives a direct current and drives an alternator, which in turn drives a 10-hp and a 2½-hp alternating motor. Other ap-



PERSPECTIVE VIEW OF WALKER BRUSH-HOLDER.

paratus shown include a fully equipped switchboard with the company's own instruments, switches, etc.; sub-station transformers, primary fuse-boxes; meters, switches, etc. The ammeters and voltmeters attract considerable attention.

The Payne Engine Company, Elmira, N. Y., has a 35-hp engine in operation, driving a 25-kw Card dynamo. The Card machine, which is very clearly shown in the illustration herewith, is made by the Card Electric Company, Mansfield, O. It has four poles, and is slow speed. The Card Company makes generators for power transmission and isolated lighting, slow-speed stationary motors, reversible motors and controllers. All of its machines are well designed, and said to be efficient.

The Brush Electric Company.—Through error the statement was made in the last issue of The Electrical World that the Brush Electric Company, of Cleveland, now manufactures arc dynamos exclusively. The Brush Company wishes us to correct this statement and to say that it is now manufacturing electric light and power apparatus, which includes arc dynamos and lamps, switchboards and all fittings, etc., pertaining to the arc system, also incandescent dynamos and apparatus for the distribution of power.

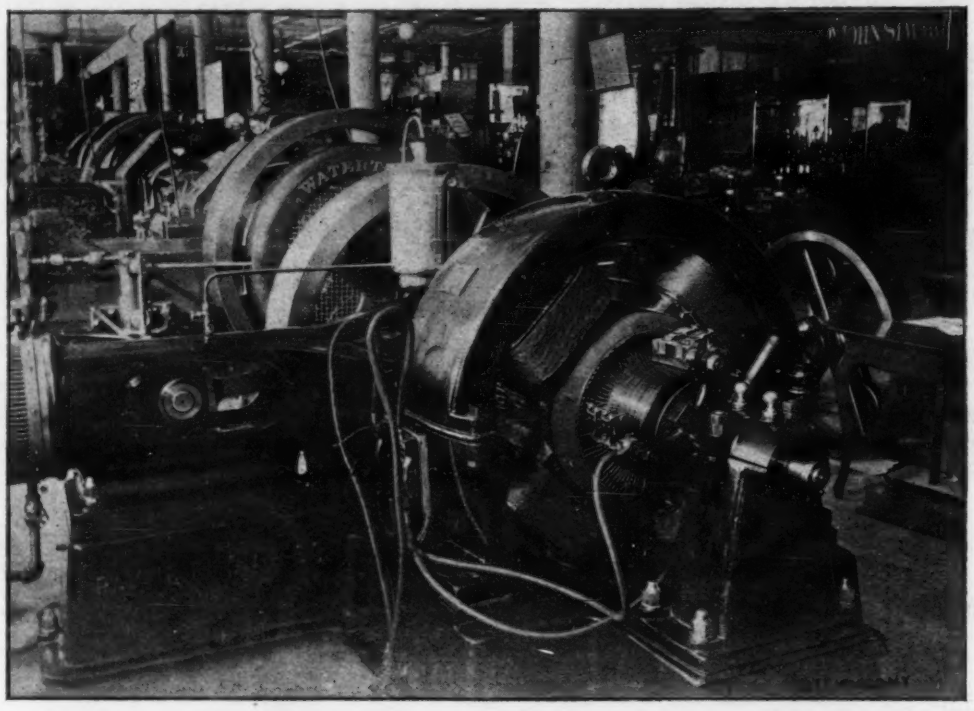


Exhibit of the Payne Engine and Card Dynamo.

De Veau & Co., New York, occupy one of the most desirable locations on the main floor—right at the main entrance on the left. Their exhibit is a very attractive one as is shown in the illustration. A full line of telephone apparatus manufactured by this firm is well arranged about the booth, and in the show case are shown the various accessories and parts of their telephones.

The Ferracute Machine Company, Bridgeton, N. J., has an exhibit on the northern isle, space G152. It has running with motors three of its improved presses adapted for electrical work. One of these is a C_3 for cutting armature discs. It also shows a punching press P_3, which is especially adapted for instrument work and all other machine cutting, punching and forming in thick metals. At the front of the exhibit is one of the smallest sizes of these presses, with an automatic index attachment for notching armature discs from 3 to 36 inches in diameter. It is adjustable so it will punch any number of teeth, or notches, and various shapes of notches, and it does the work very accurately. It is driven by a motor mounted upon a shelf at the back of the press frame, and illustrates the best type of notching press in the market. All of the presses are running and with dies set making aluminum souvenirs.

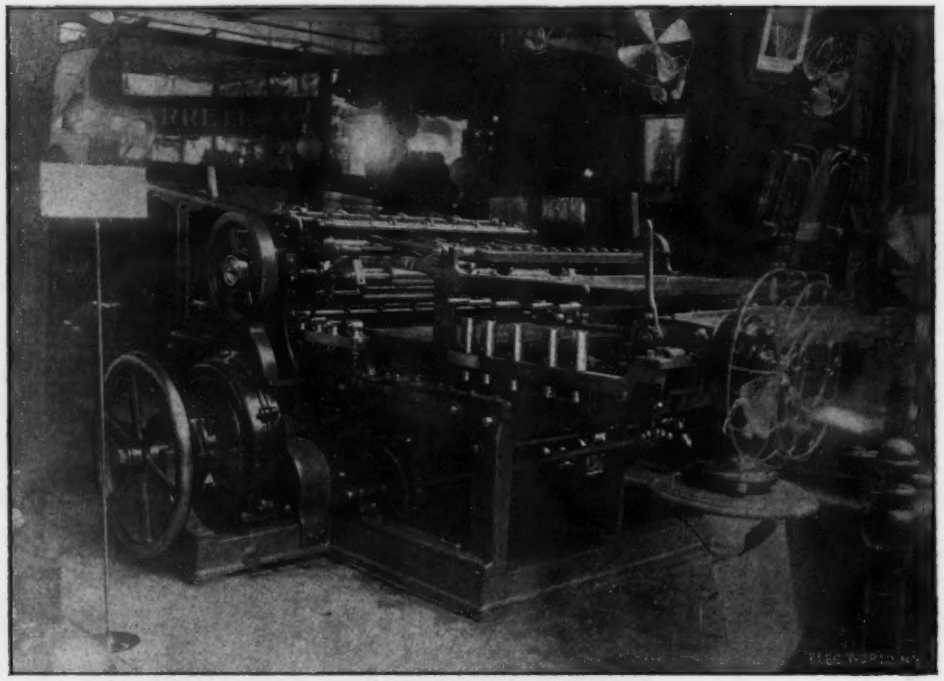
The New York Safety Steam Power Company is represented by a working exhibit. A 100-hp engine is belted to a 65-kw Crocker-Wheeler dynamo, the power generated by the dynamo being utilized in the exhibit of the Crocker-Wheeler Electric Company. The accompanying illustration shows this combination set.

The Ball & Wood Company exhibit consists of a 150-hp engine, which is directly connected to a Siemens & Halske generator. The feature of the engine consists of the new governor, which is an improvement. In its construction a leaf spring is substituted for the spiral spring. This is clearly shown in the illustration given herewith. The generator driven by this engine is a six-pole Siemens & Halske machine of 100-kw capacity. The commutator is on the circumference of the armature.

The Interior Conduit & Insulation Company has already been described, but we call especial attention to the Lundell motor connected to drive a printing press, which forms a part of the general exhibit. The Lundell motor is well known for its adaptability to such uses. Its compactness commends it most strongly, and its efficiency is well-known. We present an excellent illustration of this combination. The motor is of two horse-power, and has a speed of only 175 revolutions per minute, which indicates a large torque.

Exhibit of De Veau & Co.

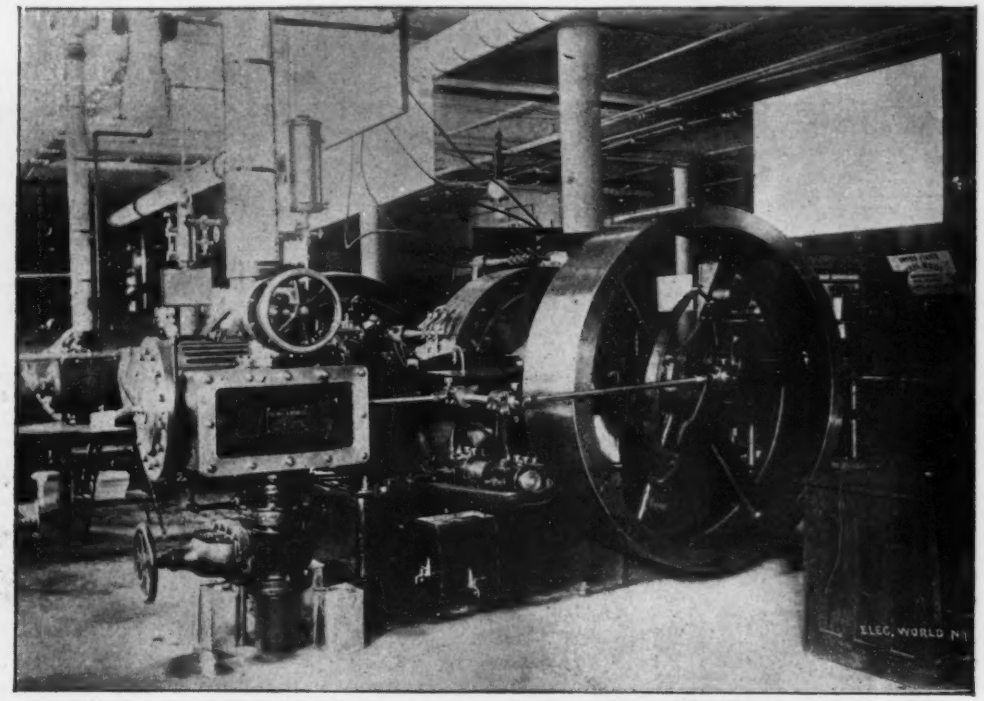
The Abendroth & Root Manufacturing Company, New York, with the only working boiler plant in the Exposition, illustrates the perfection to which boiler operation and management have been brought by placing its exhibit in charge of a female engineer. Mrs. Frank Walton enjoys, we believe, the distinction of being the only engineer of her sex in charge of such a plant. She has certainly shown excellent skill and judgment in the manner in which she has managed the plant. It is interesting and significant to see her subordinates with grimy faces and oily hands running to her for instructions and to make reports. Mrs. Walton's dress does not indicate the character of her duties as chief engineer. She says she has always taken a deep interest in machinery, and that when she married an engineer, she soon learned how to look after boilers and engines. Now that she devotes her whole time to the work, she finds it entirely congenial. The illustration shows Mrs. Walton and her assistants and the main features of the exhibit, which were described quite fully in the May 19 issue of The Electrical World.



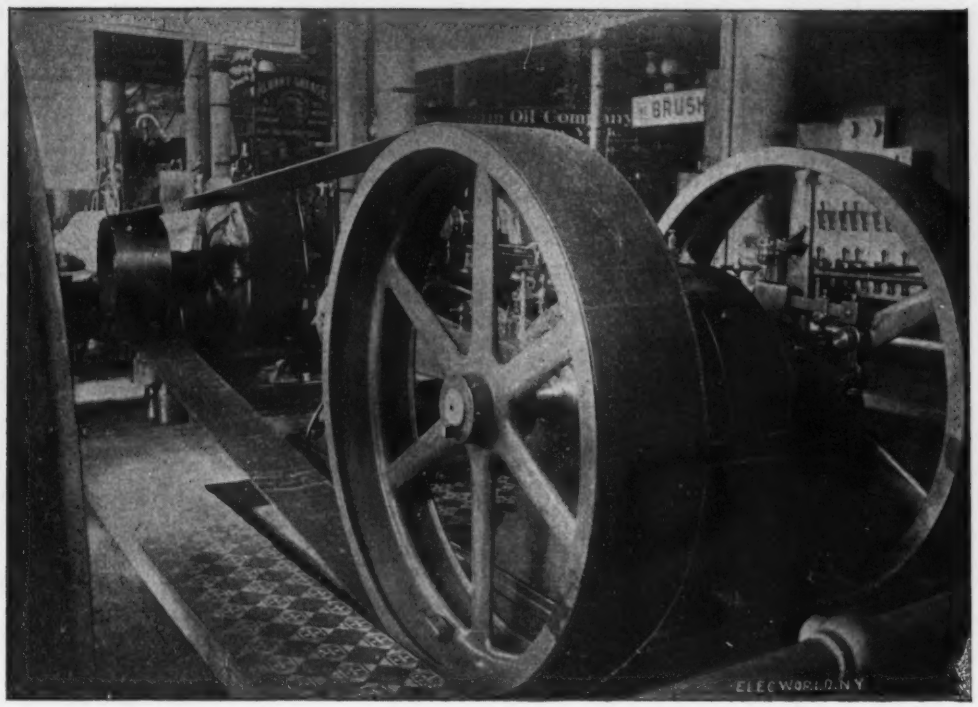
PART OF THE EXHIBIT OF THE INTERIOR CONDUIT & INSULATION COMPANY.

THE IMPROVED ROOT WATERTUBE BOILER
MANUFACTURED BY ABENDROTH & ROOT MFG CO.
28 CLIFF ST. NEW YORK.
CHICAGO. CINCINNATI ST LOUIS. BALTIMORE
ELEC. WORLD N.Y.

EXHIBIT OF THE ABENDROTH & ROOT MANUFACTURING COMPANY.



FALL & WOOD ENGINE RUNNING SIEMENS & HALSKE GENERATOR.



NEW YORK SAFETY ENGINE AND CROCKER-WHEELER GENERATOR.

The Warren Electric Company, one of Chicago's leading electrical enterprises, exhibits one of its alternators belted to a 90-hp Weston engine, and a still machine of the same class. The feature of the Warren alternator, as has already been explained, is the absence of moving wire, collector rings and brushes. It is of the induction type and wound for any voltage. The illustration gives a very clear view of the two machines referred to.

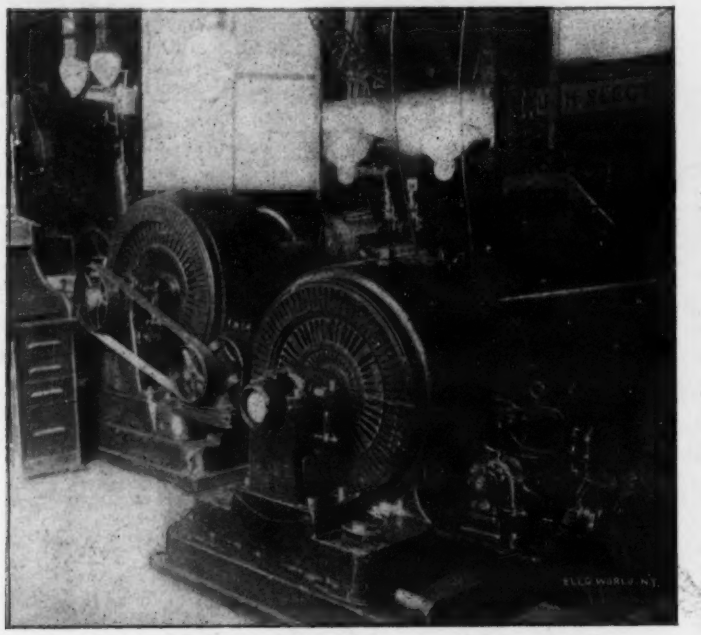
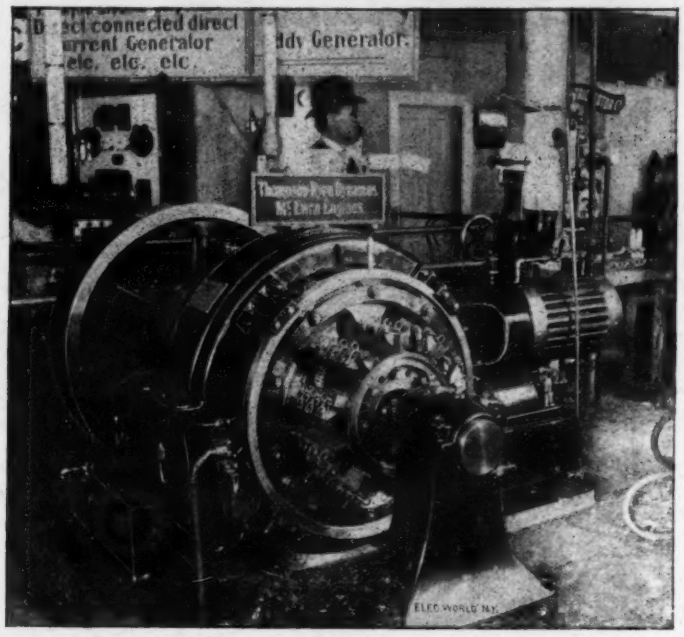


Exhibit of the Warren Electric Company.

The J. H. McEwen Manufacturing Company's exhibit is shown in the accompanying illustration. It consists of one of the company's 65-hp engines driving a 40-kw Thompson-Ryan generator, which is made by the McEwen Company at its shops in Ridgway, Pa. The McEwen engine is well known to the electrical trade for its good qualities, and the Thompson-Ryan generator is constructed on scientific principles. The machines on exhibition are in practical operation, and attract attention by their excellence of finish and appearance.



McEwen Engine and Thompson-Ryan Dynamo.

The Wagner Electric Company, St. Louis, Mo., makes an excellent display of its well-known apparatus. The Wagner transformer, it is needless to say, constitutes the main feature of the exhibit. The transformers are equipped with extra long fuses which can be removed and replaced without danger of shock. Wagner fan motors and switches are also displayed. The booth was lighted by different types of arc lamps, and was altogether an attractive one, as shown in the illustration.

Wagner Electric Manufacturing Company's Exhibit.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

DYNAMOS, MOTORS AND TRANSFORMERS.

Theory of the Alternating-Current Dynamo. GOLDSBOROUGH. *Phys. Rev*, May-June.—A mathematical article including a polar diagram by means of which the effects produced under different conditions of resistance, induction, capacity, frequency, etc., may be studied and a large variety of problems can be treated.

LIGHTS AND LIGHTING.

Public Lighting by Arc Lamps. BLONDEL. Lond. *Elec.*, May 8; conclusion of his serial (see *Digest*, last week).—He discusses the use of alternating-current arcs; as yet, there are very few towns lighted by such arcs; he investigates the most suitable means of utilizing these arcs and compares them with the continuous-current arcs. For an equal number of watts an alternating arc requires a much lower voltage, 28 to 32, instead of 45, and there is consequently an increased current, although the number of true watts is really lower than the product of the amperes and the volts, the difference however being small; for an equal power 1.5 times more current is needed, and this increased current necessitates the use of larger conductors and carbons; instead of increasing the current, it is generally better to increase the number of arcs, and public lighting can therefore not be carried out exactly in the same way as with continuous arcs; a 10-ampere lamp of the former is equivalent, as far as the watts are concerned, to a seven-ampere continuous arc, and there is therefore no need to use smaller lamps, as it involves a decreased stability and a greatly reduced luminous efficiency. In a table he gives the details of the lamps used at Cologne, which show that the diameters are proportionately less than those which he previously gave for continuous arcs, and it might be advantageous to still further reduce them; in the French lighthouses a current density of 2.5 amperes per square millimeter is adopted. The photometric curve of the alternating arc is given and discussed; the upper half is generally more fully developed, as the upper carbon becomes more pointed; at least half the light therefore is sent upward; in using diffusing globes the curves are distorted so as to incline toward a circular form more readily than with continuous arcs; such curves are shown; the efficiency, that is the useful hemispherical flux as compared with the total produced, was found to be 34.5 per cent. for ground glass globes and 27.5 for opal globes; with clear glass an efficiency higher than 40 per cent. cannot be hoped for; it is therefore a mistake to use the alternating arcs in the same way as the continuous arcs and the use of the former is not rational unless a special equipment of reflectors or dioptric arrangement is used. A satisfactory reflector should embrace as nearly as possible a hemisphere; this can hardly be obtained if outside of the globe and it is much better therefore to have them inside and quite close to the arc; the arrangement used by the Helios Company, in Cologne, is described and illustrated; it has been used with success; a white enamel reflector is fastened to the guide rods just above the arc of a focussing lamp; the curves with and without the reflector are given, showing that the distribution below the horizon follows about the same law, but the intensities are almost doubled by the use of reflectors; the hemispherical intensity is increased from 150 to 372 candles; the mean intensities are, without reflectors, 275 spherical candles and without reflectors 498 hemispherical candles for 310 watts; the second he thought to be exaggerated; it is thought that a diffuser of this kind cannot reflect more than 70 or 80 per cent., and the luminous efficiency of the lamp and reflector would be 85 to 90 per cent., which is very good. Holophane globes would also give a good solution to the question, in some respects a better one, but they have not yet been practically tried. In comparing the luminous efficiency of the two arcs he states that it seems that for an equal energy the alternating arc produces less luminous flux which he thinks is due to a less degree of incandescence; for equal power an alternating arc requires larger conductors and larger carbons; it also has altogether different properties according to the nature of the carbon used; the percentage is difficult to establish on a precise basis; the power factor of the arc is sometimes as low as 0.7 or 0.8 and arcs of less than 12 amperes are very unstable; the power factor may reach 0.95 to 1; that is, the apparent watts may differ very slightly from the true watts, the stability of the Helios lamps is so good that one may dispense with impedance coils; the advantages are due to the conductivity of the arc owing to the vaporization of the salts contained in the core, but this is probably obtained at the expense of the luminous efficiency; the Helios arc lamp, which is at present the most prominent, may be said to be intermediate between incandescence and the arc proper. In Prof. Fleming's measurements the ratio of the efficiencies is about 2 to 3, while the Frankfort Commission found it to be 4 to 5, under which conditions the downward flux for equal power is only one-third without a reflector and one-half with; Wedding and Roessler found with a Helios lamp and a reflector 0.7 to 1.1 spherical candles per watt, while a continuous-current lamp of the same power gave 2.64; with ordinary carbons he thinks 1 to 1.5 candles per watt could be obtained; experimentally, as well as theoretically, the alternating arc has a lower efficiency. He discusses the ways of avoiding the use of alternating arcs for public lighting; using separate series systems (continuous currents) calls for a special plant, which is always expensive, and has its disadvantages; it does not permit the use of lamps of different candle-power; it is generally easier and quite as efficient to connect the lamps to the general system of distribution; the rectifier system used at Portsmouth, Cardiff and Blackpool has given very satisfactory results, but it is quite possible that the luminous efficiency of such arcs will be less than of a continuous-current arc; the special transformer has a lower efficiency, and there is danger in having to handle the commutators for such high voltages; he thinks it preferable to convert the alternating currents into continuous ones at constant potential for distribution in parallel; the efficiency of such a transformer is about 87 to 90 per cent., and this enables a much greater quantity of light to be obtained with the same amount of energy than could be obtained by the direct use of alternating currents; the properties of alternating currents are variable according to the form of their curve. In his general conclusions he states that the problem is a very complex one and that we are far from a definite solution; lamps are almost always fitted with carbons of too large a size and too short a travel; bad globes are often selected; we are still not sufficiently advanced for the use of alternating arcs; many things must be done before the best luminous efficiency is obtained; a good focusing lamp with multiple carbons is desired; the photometric value of alternating arcs is still very doubtful, and it seems well to replace them with pulsating or continuous arcs when possible. In an appendix he gives the results recently obtained of the measurement of 10-ampere continuous arcs under different conditions; some curves for these are given, showing the relation between the voltage and the flux; the maximum efficiency is found to be about 45 volts for these carbons. In a second appendix data relating to various public arc lighting plants is given in the form of a table.

A New Lamp. SCHNABEL. *Elek. Anz.*, May 3.—A brief communication in which he describes what he considers a valuable discovery; it relates to a mass which has the following properties: the temperature to which it can be raised seems to be unlimited as it does not evaporate at 3000° C. although it melts at 1900° C.; it is not at all acted upon by the air; the light from it is quite white with about a quarter of the consumption of energy in an incandescent lamp; the lamp consists of a plate of marble with a furrow cut in its surface having enlargements at the end for connection with the terminals of carbon; the current consumed was 4 amperes at 4 volts; the light produced was equal to 20 candles and was quite white, containing more yellow than violet rays; the weight of the mass was 0.25 gram; the cost of a kilogram of this material is $1.50; it is used in the form of a powder; the temperature of the glowing mass was tested with pieces of iridium wire which melted immediately and soon volatilized. Editorially it is stated that this would correspond to a consumption of 0.8 watt per candle, while in an incandescent lamp it averages from 2.5 to 2; owing to the low voltage it could not be used in the ordinary systems of distribution; the discovery will probably be of value if the facts given can be substantiated, if the cost of production is small and the life sufficiently long.

Method of Making a Steady Platform for Searchlights at Sea. TOWER. Lond. *Elec. Eng.*, May 8; an illustrated description of the apparatus.—It is known that any device suspended on the principle of the pendulum will not operate, as a pendulum will for such oscillations remain perpendicular to the surface of the wave; in the present form the instrument is placed on a platform which is hung in gimbals carried on four plungers which operate in cylinders into which water is admitted under pressure by means of a gyroscope.

Electric Theatre Lighting. FEUERLEIN. *Elek. Zeit.*, May 7.—A very long profusely illustrated article describing the apparatus of the Siemens & Halske Company, used in stage lighting.

Vacuum Tube Lighting. *Elec. Rev.*, May 20.—A reproduction of a photograph obtained by a two-second exposure to the light of a single vacuum tube lamp of small dimensions, recently devised by Tesla; he stated that photographs obtained by the light of such powerful tubes show an amount of detail that no picture taken by sun or flash light is capable of disclosing; he is said to have succeeded in increasing the

candle-power of the tubes to practically any intensity desired; no further technical data is given.

Industrial Development of Electric Lighting. METCALF. *El'ty*, May 20.—An article of an historical nature, including also some data for some of the recent large stations.

POWER AND HEAT.

Transmission of Power from Montmorency Falls. CHESNEY. *Cassier's Mag.*, May.—A long, well-illustrated description of the transmission plant; the dam above the falls has a minimum capacity of about 12,000 horse-power; the height of the falls is 275 feet and the distance to Quebec to which the power is transmitted, is eight miles; the turbines used have a capacity of 700 horse-power at a speed of 600 revolutions, and are only 21 inches in diameter; the S. K. C. two-phase system is used; there are two independent circuits and the transmission voltage is 5200 to 5700 with a frequency of 66, which was adopted in preference to double this, the usual frequency, as the self-induction drop in the transmission lines was an important factor, even though the core loss in the transformers was thereby increased from 20 to 30 per cent. and the regulation of the generators from 2 to 3 per cent.; there are two separate pole lines each having a capacity of 500 killowatts, the line wire being No. 0 B. & S. bare copper; the line drop is 8 per cent. which is increased by the self-induction to 10 per cent.; along the tops of the poles are strung galvanized iron wires grounded at every third or fourth pole; the generators are the S. K. C. inductor type, two-phase machines each generating 5,700 volts and 100 amperes; they are said to be the largest inductor machines built and the first and only ones for such a high initial E. M. F.; the armature is stationary; the impressed E. M. F. is sinusoidal or very nearly so, as it was found by him that the use of any other than a sinusoidal E. M. F. resulted in losses in the transformers and in the unsatisfactory running of the motors; the entire distributing system has been arranged to run in parallel and in order to overcome the objections to paralelling such high voltage machines the mains from the different machines are kept separate and the secondaries of the step-down transformers are connected in parallel; unless therefore the line from one generator has two weak points there is no leakage and it can affect directly only one generator; in order to keep the generators in phase under these conditions a separate and distinct synchronizing winding is used giving 120 volts and having a synchronizing capacity of about 100 kilowatts, which together with the paralleling of the secondaries is sufficient to give perfect parallel running; the motors used are of the induction type described by Bell in *Cassier's Mag.* for January, and vary in size from 1 to 30 horse-power; the magnetizing current is furnished by condensers so that the motor takes current in proportion to its load; for every 100 kilowatts delivered to the shaft of the generator, 95.1 are delivered to the line at the generating station, 87.5 to the terminals of the step-down transformers and 86 to the distributing mains of the sub-station.

Long-Distance Transmission at Lowell, Mich. Elec. Eng., May 20, and *West. Elec.*, May 23.—A brief, illustrated description of a recently installed plant; there are three vertical turbines of 100 horse-power each, generating an alternating current at 1000 volts, which is raised to 10,000 by transformers and transmitted to Grand Rapids, 18 miles distant; the frequency is 66; the current is used for light and power indiscriminately; the motors used are S. K. C. type with condensers.

TRACTION.

Underground Railway at Budapest. Lond. *Elec. Rev.*, May 8.—A short note, including an illustration of the end of one of the cars, which is of interest, in that the cars are very low, owing to the small size of the tunnel; the floor of the car is only a few inches above the rails. It is thought that the road will be open for traffic in June; the stations are 400 metres apart, and the maximum speed will be 40 kilometres per hour; a novel system of automatic speed regulation has been adopted, avoiding the necessity of any intelligence on the part of the motorman; he can only cut the motors in and out, but cannot regulate the speed; a solenoid is connected to the terminals of the motor, and as the counter E. M. F. increases the magnetism of the solenoid will do likewise (no further description is given); it can be set in such a way as to practically fix the distance in which the car will attain its maximum speed; electric brakes similar to the Sperry type are to be used; the height of the tunnel from the top of the rail is only 2.85 metres; a car contains 29 seating places and room for 15 to stand up; the total weight is 12 tons and each car contains one motor of 50 horse-power on each truck; the current is taken from an overhead conductor in the roof of the tunnel; the tunnel and stations are lined with glazed tiles; the line was constructed for connecting the railways encircling the city with its centre, surface railways not being permitted in the residential quarters through which this line would have to pass.

Secondary Batteries for Electric Locomotion. FITZ-GERALD. Lond. *Elec. Rev.*, May 8; a continuation of his serial (see *Digest*, May 2).—He shows by means of simple calculations how very great the economy in the annual expenditure is, owing to a diminution of one ton in the weight of the batteries; he gives a general formula, and applies it to a certain line with easy grades and curves, finding that a diminution of one ton in the weight of a battery will result in the saving of nearly one horse-power applied to the driving-wheels, or about three horse-power of that generated by the steam engines, which amounts to about $61.50 per year counting 15 hours a day and not including the cost of maintenance. The main question therefore is how can the weight be reduced and what must be avoided in endeavoring to effect this economy; in reply to the latter he states that too high a current density must be avoided as also the conditions which render it destructive; also an unnecessarily extended discharge—that is, one should avoid trying to get too great a capacity simultaneously with a high rate of discharge; an unnecessary weight of the electrolyte should also be avoided; durability and high rate of discharge are the main requirements; to obtain these the conducting support should be protected from local action and the active material from disintegration; the active materials should possess in the highest degree the necessary chemical and physical properties, and the peroxide should be hydrated, coherent, but of high conductivity, while the spongy lead should be porous and yet conductive; the contact with the active material must be complete and perfect; the forming should proceed from without inward, and the discharge should never be allowed to extend to the supports, which latter should be enveloped in a very dense, thin layer of peroxide; direct contact between the metals and the electrolyte should be very imperfect; the sectional area of the supports should not be diminished too much; the acid should have a density of 1.3 provided the local action on the lead can be avoided; the spongy lead should not be more than half in weight of the peroxide. He enumerates six different compounds which have been used for active materials; the red lead salt of Frankland is obtained by the action of sulphuric acid on red lead; this is anhydrous and has not the same composition as electrolytic peroxide, its conductivity is low and the active material is of very inferior description; it should be particularly avoided in high rate plates; the buff lead salt of Frankland is used chiefly for spongy lead which latter, however, is said to be too dense for high rates although otherwise of fairly good quality; Fitz-Gerald's ammonia lithanode compound made of lead oxide and ammonia sulphate sets gradually after mixing and the peroxide has a high conductivity; Fitz-Gerald's sulphate lithanode compound is made by mixing the sulphate with the monoxide of lead and is said to form excellent peroxide and spongy lead material; Fitz-Gerald's alkaline plumbite compound is made of a mixture of monoxide of lead with a salt consisting of potassium, lead and oxygen; by exposure to the air after pasting it sets very gradually and perfectly after which it is immersed in sulphate of magnesium and then formed in the same salt acidulated with sulphuric acid; any desired porosity may be obtained with very little loss of cohesive strength; lastly he describes the lead-zinc chloride compound used in the chloride cells.

Earth Connection Safety Device for Trolley Lines. ULBRICHT. *Elek. Zeit.*, May 7.—He discusses the protection due to grounded guard wires and points out where they fail; in one case a loose wire on making contact between the two, melted off above the trolley wire and then hung in contact with it, thereby becoming very dangerous for those who pass on the street. To overcome these objections he devised a system in which a momentary ground connection, by releasing a switch with the aid of a magnet, makes a permanent ground connection with the trolley wire, thereby rendering the latter harmless until the fault can be repaired by the proper authorities; trials were made to show the apparatus to be very effective; it is now used on the railways in Zwickau. The apparatus is also of use in case of a fire, when the trolley lines may be cut out of circuit by grounding them momentarily.

Rouen. L'Ind. Elec., April 25.—An illustrated description of the electric railway system in that city.

Tramways and Telephone Disturbances. WEST. Lond. *Elec.*, May 8.—A translation of the article abstracted in the *Digest* last week.

Electricity on Steam Roads. BAXTER. *Elec. Eng.*, May 20; a continuation of his serial (see *Digest* last week).—He concludes the estimate of the reduction in expenses of the Pennsylvania Railroad Company if electricity were used instead of steam. The whole of the cost of the water supply of the locomotives would be saved; the saving in the supplies of locomotives, such as oil, waste, packing, etc., would be about 75 per cent.; the items covering the wages of switchmen, flagmen, dispatchers, etc., and of other expenses in connection with signaling and telegraphy, he thinks will be reduced at least 5 or 10 per cent., and he suggests that the automatic block system should be used, in which the motion of all the motors on the road would be controlled one by the other, thus making collisions practically impossible. In a table he gives a summary of all the savings, and finds that it amounts to more than $7,500,000 annually, which is over 18.5 per cent. of the total operating expenses; he reconsiders these items again to show that the estimate has been very conservative, and points out other items which he thinks one is justified to claim; he thinks the results could be fully realized in practice; it is intended to follow this with an estimate of the cost and capacity of an electrical equipment for that road.

Cost of Motor Maintenance. St. Ry. Rev., May 15.—The beginning of an article made up of reports received in answer to questions sent out to a number of roads with the object of settling the various questions as to the most economical methods of maintaining motor equipments; the answers from 10 different roads are given.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Combined Alternating and Continuous Current System at Brighton. Lond. *Elec.*, May 8.—A brief description of the combination system which has been in use since 1894, and has given perfect satisfaction, besides showing a substantial gain in the coal economy. The outlying districts during the greater portion of the 24 hours are supplied with continuous currents, while during the few hours of heavy load the alternating current is used. In the outlying district there is a high-pressure alternating-current ring main which is tapped at intervals by transformers, the secondaries of which are connected to the three-wire distributors; a low-pressure distributor is run to each of the two transformer substations, thus enabling the district to be connected to either of the two circuits; the continuous current is used between 11 p. m. and sunset of the next day. A very reliable system of interlocking had to be devised; the system of keys and locks is shown; the bicycle switchman in pulling a lever connects the distributors of the section to the secondary of the live transformer and disconnected the entire system from the continuous-current supply; by locking the switch the keys are released, and with this he is able to release the switches of the transformers in the other stations belonging to the section, and to thus connect fresh alternating-current feeding points to the distributors; in the evening he commences at the feeding stations, switching them off in succession and gradually throwing the entire load on to the change-over station; with the keys thereby released he goes to the change-over station and releases the switch which connects the district to the main. There are nearly 100 consumers supplied with this double system, representing some 4000 lamps; a curve giving the consumption of coal per unit shows how economically the station is operated. The alternating-plant load factor reached the high figure of 60 per cent.; the meters must of course register equally well with the continuous and alternating currents, which requirement is fulfilled by the Thomson meter.

Electric Supply Data. Lond. *Elec.*, May 8.—Some diagrams showing the relations of various data for a number of English stations, accompanied by tables giving the figures; one of these shows the relative efficiencies of the systems of distribution; the losses of the distribution are least for the three-wire systems without batteries, next in the battery systems and greatest in the transformer systems; the percentage load factors are as a rule greater for the battery systems than for those without batteries; another gives the maximum demand factors which represents the ratio of the maximum actual demand and the total capacity of the station; in a battery system this may exceed 100 per cent. though it rarely does; it shows to what extent there is superfluous generating machinery, while the load factor indicates the extent to which the hours have been filled up by work; the diagrams show the maximum demand factors to average considerably more for the battery systems than for those without batteries.

Paris. LAFFARGUE. *L'Ind. Elec.*, April 25.—An illustrated description of some length of the new sector on the left bank of the Seine, in Paris; it is the first central station on that side of the river; the alternating-current system is used, the generating station being at some distance from the city.

St. Pancras Vestry. Lond. *Elec. Eng.*, May 8.—A report of the working of this system for the past year with an abstract of the accounts.

Best Distances Between Transformers. HAAS. *L'Ind. Elec.*, April 25.—A French translation in part of the article which was abstracted and illustrated in the *Digest*, March 21.

Distribution of Energy from Central Stations. EGLIN. *Proc. Eng. Club Phila.*, April.—A reprint of a paper descriptive of the system used at the large Edison station in Philadelphia; he favors the use of boosters in preference to the other ways of accomplishing the same object; among the diagrams is one showing the candle-power of a 16-cp lamp for a rise and a drop of 10 volts; at 100 volts for instance the candle-power was 10, at 110 about 16 and at 120 it was 30-cp, the curve having a slight curvature upward; there is also a load diagram of that station showing a very sharp peak between 5 and 6 o'clock, p. m.; an illustrated description of the underground system used, is given.

Central Station Economics. ABBOTT and DOMMERQUE. *Elec. Eng'ing*, May; a continuation of their article.—The present section is devoted entirely to the discussion of coal and its heating properties.

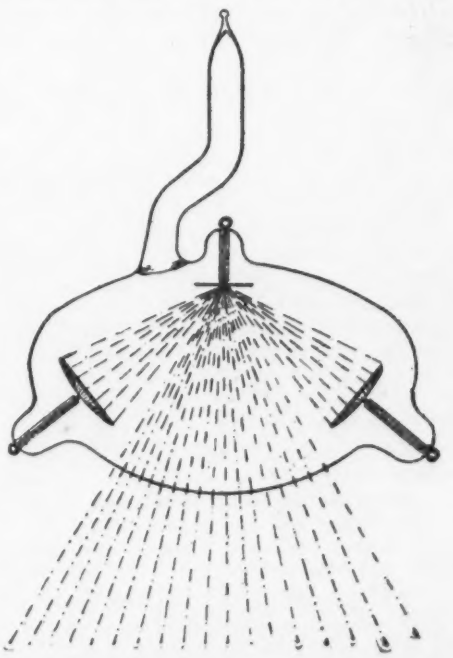
An Historic Electric Central Station. LIEB. *Cassier's Mag.*, May.—An extract of a recent paper read before the New York Electrical Society describing the old Pearl Street Edison Station in New York.

ELECTRO-PHYSICS AND MAGNETISM.

Röntgen Rays. L'Ind. Elec., April 25; abstracts of Academy papers. BENOIST and HURMUZESCU; owing to the different results obtained by various experimenters, they repeated their researches on the action of X-rays on electrified bodies, with the gold leaf electroscope and found in all cases a complete discharge, whatever the initial charge was, and a complete absence of all subsequent deflection; they believe that the molecular theory does not explain these results and that the property possessed by dielectrics of becoming conductors under the action of these rays, as stated by Thomson, is not sufficient for explaining all the conditions of the phenomenon. They believe their results indicate the direction in which to look for more sensitive plates than the ordinary ones consisting of bromide of silver; the platinum salts being more absorbent would no doubt be much better, a fact which they intend to verify.—BEAULARD studied the refraction of the rays in a vacuum with a prism of ebonite; he was not able to find any decided deviation but it seemed that the spot obtained was slightly oval.—SAGNAC, in a paper on the diffraction and polarization of these rays, showed that those which affect the sensitive plate through the wooden cover of the holder, have a wave length which is not greater than 0.04 of a micron; he thinks polarization is best examined by means of absorption.—IMBERT and BERTIN-SANS used the stereoscope method for locating objects in the human body and obtained very good results. BUGNET and GASCARD used a sort of triangulation method for the same purpose.—ERRERA describes some experiments showing the action of X-rays on phycomyces, which, submitted to an unsymmetrical action of many external agents, become curved; the results with X-rays were negative.—HENRY gives a summary of the results obtained with these rays; he believes it is almost certain that they are ultra-ultra-violet; that cathode rays are really nothing else than Röntgen rays, together with convection streams of materials; in the cathode rays a magnet deflects that which is analogous to a constant current, but it does not deflect Röntgen rays which have the characteristics of alternating currents; he believes that all sources of light, when sufficiently intense, emit X-rays, but to a very slight degree as compared with the Crookes tube; he discusses the subject of phosphorescence in connection with these rays.

Some brief abstracts from the last number of *Comptes Rendus* are given in the Lond. *Elec.*, May 8. COLSON concludes from experiments that the rays act directly on the photographic plates, and not by means of transformation. LE ROUX, in a paper on the heterogeneity of the rays, found that pieces of metal were apparently more easily traversed the thicker they were; cardboard was relatively opaque, although when placed on a piece of metal the two were transparent; the gelatine was tinted red; the curious results are said to have been solved by Becquerel's discovery that the so-called X-rays, due to phosporescence, traverse metals more easily than those derived from Crookes tubes, and are reflected; the coloration of the gelatine is thought to be due "to a sifting effect of the cardboard screen"; he suggests the term hyperdiabatic rays.—BENOIST and HURMUZESCU found that, all things being equal, the rate of discharge of a charged body varies as the square root of the density of the gas in which it is immersed; they suggest the hypothesis that the behavior of electrified bodies under the influence of these rays is due to the expulsion by the body under their influence of the molecules of gas condensed on the surface or occluded at a certain depth. A paper by LAFAY describing electrification experiments is also briefly noticed.

Focusing Tube for Alternating Currents. SWINTON. Lond. *Elec.*, May 8.—A brief, illustrated description of a tube for use with alternating currents such as those from the Tesla apparatus; the tube is shown in the adjoining illustrations and was made in that form more than two months



ago; the two curved aluminum discs are alternately cathode and anode, each focusing its cathode rays on the identical portion of the flat platinum reflector; if carefully made, so that the foci of the two discs are exactly on the same spot, the tube will be found to work well; by connecting both discs together and using them as a cathode, making the platinum disc the anode, the same tube can be used with Ruhmkorff coil currents; no further information is given.

The Lond. *Elec. Rev.*, May 8, gives a brief notice of some recent quantitative results regarding the rate of leakage in different gases, recently

obtained by J. J. Thomson and McClelland; in general the rate of leakage increased with the atomic weight of the gas, but this is not without exception; the rate of leakage was greatest in mercury vapor through which the ordinary electric discharge passes with great difficulty; the connection between the rate of leakage and the voltage was found to be remarkably similar to the relation between the ampere-turns and the magnetism induced in iron; when the voltage does not exceed two or three the rate is proportional to it; with very high voltages it is almost independent of the voltage; in solid dielectrics such as paraffine the rate was found to follow the Ohm's law up to the highest voltages.—Ackroyd and Knowles showed a connection between the color of bodies and their transparency to the X-rays; oxide of aluminum, which is white, is transparent, oxid of chromium is green and semi-opaque and ferro-oxide is brown and opaque; they found a similar law to hold good with other groups.

Analysis of Vegetable Materials by Means of X-Rays. Ranwez. *L'Ind. Elec.*, April 25.—An abstract of an Academy paper in which he shows that these rays may be used in practice in the analysis of certain vegetable materials which are often adulterated by the addition of mineral matter; this method has the advantage that only small quantities are required, the samples are kept in their original form; the test is readily made, and the photographic record is an absolute proof; experiments were made with samples of adulterated saffron and the photographic records gave very clear results.

Shielding Action of Steel. Beck. *Wied. Ann.*, Vol. 57, page 464; abstracted briefly in the *Elek. Zeit.*, May 7.—Foeppl in his theory claims that hard steel will have a screening action for magnetism and that if placed around a wire, the lines of force generated cannot pass through it. To test this the present writer passed a current through a wire surrounded first by a steel tube, then by one of iron, and then with nothing around it, and measured the current induced in a neighboring wire when that in the former was reversed. The results are given and show that there is practically no difference in the currents induced in the second wire, the results being practically the same for each of 12 different currents; he therefore concludes that steel can exercise no screening action.

Photographic Study of the Arc Spectra. Baldwin. *Phys. Rev.*, May-June.—The concluding paper (see *Digest*, April 11) giving further results. The spectrum obtained from the arc is not the same for all of its parts there being a decided difference in the several sheaths, which is due largely to the fading out of the carbon bands and of all the lines from the positive carbon, and to an increase of the intensity in the outer sheath, of the lines most brilliant near the negative carbon; certain lines and bands which are invisible in the centre are seen in the outer part of the flame; the total number of metallic lines diminishes rapidly as the arc is explored from the centre outward; when metals are introduced which are more positive, they greatly weaken and tend to destroy the characteristic band; the lines which are most affected by these metals are those which in the ordinary spectrum are strongest near the positive carbon; certain metals, as silver and copper, do not alter the original spectrum while others such as zinc and cadmium affect the lines near the negative carbon.

Influence of Heating and Magnetization on Young's Modulus. Noyes. *Phys. Rev.*, May-June.—A supplementary article (see *Digest*, Feb. 2, 1895) in which she describes a series of experiments made to distinguish between the effects due to the heat, to the longitudinal magnetization and to the electric current through the wire; the results obtained showed that neither magnetization nor a current produces any appreciable effect on the size of Young's modulus aside from that attributed to the accompanying heat; all the wires showed a permanent increase in elasticity produced by heating them, this being greatest in silver at least in copper; the temporary effects of heat on the elastic limit of silver and copper wires are very marked; in electric circuits it was found that the copper wire stretches much more during the Summer than it contracts in the cold, indicating that it probably stretches beyond its limit; the fact that copper wire varies so much from the effect of heat on the elastic limit, may need to be considered in selecting wires for telephone circuits or for other long spans.

Graphical Representation of Magnetic Theories. Allen. *Phys. Rev.*, May-June.—He calls attention to the importance of distinguishing between the induction theory and the magnetic fluid theory and considers some points in the former, describing a number of diagrams which illustrate the different aspects of that theory.

Röntgen Rays. *Elec. Rev.*, May 20.—It is stated that Tesla was able to see by means of an improved Edison screen, the expansions and contractions of the human heart; in some instances he could locate evident defects in the lungs of a number of persons.

Potassium-Platino-Cyanide. *Sc. Am.*, May 23; an abstract from *Science* of a description from the German by Schertel describing how this compound is made.—"Platinum chlorid is precipitated by hydrogen sulfid at 60 degrees to 70 degrees and the well-washed platinum sulfid is dissolved in a warm solution of potassium cyanid. On evaporation, the potassium platino-cyanid, K^2 Pt $(CN)_2$ HO_4, crystallizes out, and equal parts of potassium sulfid and potassium thiocyanate remain in the mother liquor. If a solution of barium cyanid is used, the barium platino-cyanid is obtained."

ELECTRO-CHEMISTRY AND BATTERIES.

Cyanide Process for the Extraction of Gold. Lond. *Elec. Rev.*, May 8.—A brief discussion concerning the relative merits of the electric and the zinc process; it is contended that the electrolytic process is much superior to the other, known as the MacArthur process; a quotation is made from a paper dated 1844, in which the use of zinc for depositing gold was described, and therefore no patent can hold good for this process. A quotation is made from a recent report of a director of one of the Transvaal mines; he states that the electrolytic process (Siemens & Halske) proved in every way successful, not only in the extraction of 79 per cent., but also in the fineness of the bullion; the experiment has proved eminently satisfactory.

Energy of a Battery During Electrolysis. Lond. *Elec. Rev.*, May 8. Jahn; an editorial abstract of a paper from the *Zeit. f. Phys. Chem.*, No. 18, page 399.—It refers to experiments made to determine "the fate of the energy of a battery during electrolysis"; he obtained the total heat developed per unit of current, first without and then with polarization; the difference in the energy necessary for the decomposition of the miligram equivalent was obtained, and from it he induces the value of polarization; a table, which is reproduced in the abstract, gives the values; this shows that the values for the polarization are in all cases very much higher than those obtained by other methods.

Secondary Batteries for Locomotion. Fitz-Gerald. See under "Traction."

Electrolytic Manufacture of White Lead. Williams. *Eng. & Min. Jour*, May 16.—A description of the Brown process which has been in use experimentally for two years; a solution of sodium nitrate is decomposed by a current, the positive electrode being pig lead and the negative a sheet of copper; this forms lead nitrate and sodium hydroxide, which are drawn off separately and then mixed in the proper proportions, yielding lead hydroxide as a precipitate and leaving sodium nitrate in solution which latter is used over again, very little of it being lost; to the lead hydroxide is added a solution of sodium bicarbonate forming sodium hydroxide and lead carbonate, the former having the property of removing most of the impurities, including organic matter; by passing carbon dioxide through the sodium hydroxide, it is reconverted into a bicarbonate and used over again. The experimental plant in Cambridge, Mass., could turn out 500 pounds of white lead per day; its success is regarded as beyond question; the cost is more than covered by the Dutch method; it is almost instantaneous as every reaction takes place rapidly and there is also a great saving in labor and materials; the texture of the product is almost molecular in fineness and therefore needs no regrinding; paint made with this lead was exposed side by side with Dutch paint for two years and no difference was detected in durability or opacity; the covering power is said to be considerably greater; the process is said to produce the globular kind and was so fine that it was almost impossible to find a filter that would retain it.

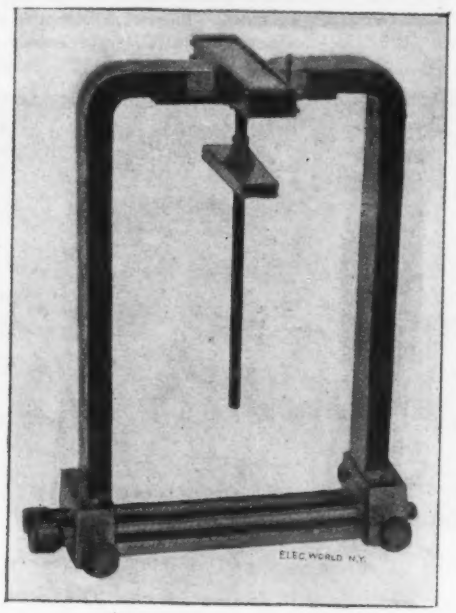
Calcium Carbide Plant at Niagara. Dunlap. *Elec. Eng.*, May 20.—A brief illustrated description quite similar to the one abstracted in the *Digest* last week; the estimated cost of producing a short ton of carbide is given as $23.

Accumulator. *Elec. Jour.*, May 15.—A short article describing some practical experience with the Bradbury-Stone accumulators.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Ewing's Permeability Bridge. Lond. *Elec.*, May 8.—An illustrated description of a new device exhibited before the Royal Society; it is a companion instrument to the hysteresis tester and measures permeability by a process nearly as simple as those of the earlier instruments for measuring hysteresis. The sample to be tested is compared step by step with the standard bar whose **B-H** curve has been previously determined once for all; the comparison is made by a process resembling the comparison of resistances in a Wheatstone bridge, but is carried out in a different way than was used in the earlier instruments of this kind. The two round bars are slipped into two parallel magnetizing coils whose ends are joined by two short yokes; the instrument is shown in the adjoining illustration, the lower part of which shows the two bars without the coils; two long iron horns project upward and nearly meet in a gap which contains a compass needle corresponding to the galvanometer of a Wheatstone bridge and serving as a detector to show when the two yokes are at the same magnetic potential, which will be the case when the magnetic induction in the two bars is the same; if the bars differ in quality, the condition of balance is produced by altering the number of turns in the magnetizing coil of the sample bar, the same current passing through both coils; to get rid of hysteresis a reversing key is used, the balance being considered perfect when the reversals produce no permanent deflection, although a transient throw will in general be observed; to prevent the current from being altered while making the adjustment, compensating resistances are introduced as the windings are cut out. The clear length of each bar is 12.56 centimetres (that is, 4π) and the number of turns around this standard bar is 100, hence the magnetizing force is 10 units for each ampere;

the induction is the same in both bars, when balance is reached and the number of turns on the sample bar then gives, by its ratio to 100, the ratio of the magnetizing force required for that bar, and the known force applied to the standard; by changing the current as many points as desired may be found; the detector is sufficiently sensitive to show the



effect of one turn and even less, which therefore corresponds to about 1 per cent. He has used this for several months, and aside from its convenience, it is even more delicate for detecting differences between samples; the primary measurement of the standard bar is made ballistically; the complete instrument contains the necessary switch dials and arrangements for altering the ratio; for testing sheet metal, the samples are made by piling up a number of straight strips; the bars fit in the holes loosely, and are pressed against the middle portions of the yokes by a pair of set screws, the effective contact being thus made in the place best adapted for shortening the magnetic circuit through the yokes.

A Method for the Use of Standard Candles in Photometry. SHARP. *Phys. Rev.*, May-June.—A description of experiments, with the results, undertaken to investigate the relation between the flame height and intensity, and to find whether this relation would make it possible to get more consistent results than by correcting for the rate of consumption; the tables and curves show that while this relation is fairly definite for a group of observations there is a considerable range of variation in different groups; by correcting for the flame height an error of less than 2 per cent. may reasonably be expected, while the probability of making an error greater than 4 per cent. is small; in correcting for the rate errors of 7 and 9 per cent. are common; it is also shown that the fundamental assumptions, on which the bolometric tests were based, are entirely justifiable; in conclusion he states that it is probably true that the best way of determining candle-power is to use the Hefner lamp and reduce by the ratio which he found.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Railway Telegraphs. LANGDON. Lond. *Elec. Eng.*, May 8.—The conclusion of his Institution paper (see *Digest*, last week) with the discussion; it is mainly descriptive in character and is accompanied by numerous illustrations of details. The paper is being reprinted in the other London journals, beginning with the issue of May 8.

Microphone. Elek. Zeit., May 7.—An illustrated description of the new form of Mix and Genest.

Electro-Pneumatic Plant. Elec. Jour., May 15.—A brief description of the combination system of the Grand Avenue junction in St. Louis.

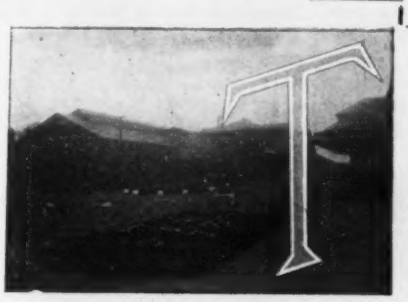
MISCELLANEOUS.

Action of the Alternating Current on Diphtheria Toxine. TJURIN. *Elek. Zeit.*, May 7.—A brief abstract of a Russian paper, in which he describes experiments showing that this material, on the passage of alternating currents, loses its infecting properties to such an extent that guinea pigs which were injected with such toxine did not become sick, while others injected the same day with the ordinary toxine died after a few days; this is claimed to show that toxine subjected to a current can be used for injections, and that animals which have been so vaccinated will be proof against the disease.

Biographical. Elec. Jour., May 15.—A full-page portrait of Wilhelm Konrad Röntgen.

Elec. Eng'ing, May.—A reprint of a recent address on Helmholtz by Rogers.

The Factory of the C. & C. Electric Company.



THE C. & C. Electric Company has an extensive and interesting factory at Garwood, N. J., for the purpose of manufacturing electrical apparatus, and its arrangement, facilities and methods are worthy of a detailed description. The factory is located adjacent to the station on the Central Railroad of New Jersey, and is of semi-fireproof construction. It is what would be designated by insurance companies as a slow burning building. The frame-work is of iron, while the housing is of corrugated iron and the sheathing of wood. It consists of a main building 100 x 500 feet and several capacious wings which reach toward and nearly abut the railroad track. A siding is run into the yard and the company rarely lets one of the numerous trains on the New Jersey Central railroad pass through the works without picking up a car well laden with its products.

The power for the purpose of manufacture is generated in three 80-hp boilers, using a fine grade of anthracite pea coal. The boilers are of the horizontal multitubular type. The coal and ashes are weighed and a careful count is kept of the economy of the system. The water is metered, the pounds of water per pound of coal estimated, and being an electrically driven plant, the watts per pound of coal are also definitely ascertained. The boilers supply steam to a 16½ x 16 Ball engine, running at 250 revolutions per minute. Belted to this engine are one 50 and one 100-kw generator, the belts running on top of one another. The plant as originally designed was to have had suitable generators direct-coupled to the engines, but the company states that the demand for its multipolar direct-coupled units has been so great that it has not been able to keep ahead of the orders sufficiently to carry out its primary intentions in this matter. The two bipolar generators already referred to supply current at 220 volts to every part of the machine shop, and by a motor equalizer system supplies current at 110 volts for lighting purposes. As previously stated the shop is driven by motors, these ranging in size from ⅛ to 12 horse-power.

The main machine shop is swept by a long traveling crane electrically operated and capable of lifting 20,000 pounds. This shop contains the heavy tools necessary in the manufacture of the larger generators. A row of powerful planers, radial drills, boring machines and special machinery for facing castings occupy one end of the shop, while at the other end machinery for doing rapid work, such as gang drills and special tools,

A NEW C. & C. MULTIPOLAR DYNAMO.

are arranged for the greatest convenience. Each of the larger tools has its special motor, and therefore can be stopped and started irrespective of the rest of the plant. The smaller tools are run in groups, each group having a separate motor. These little motors are almost all of a bipolar type, and have commutators which are wonderfully smooth—in fact, the brown gloss, which is so desirable on the closed coil moderate-voltage commutator, is almost phenomenal in these cases. The company attributes this remarkable performance to its special self-feeding carbon brush, which, from the accompanying sketch, will be seen to be unique and ingenious, and at the same time very simple. A carbon block, which is beveled at both ends, one end being adapted to rest on the commutator, while the other is partially grasped by the holder, is practically the secret of the combination. The pressure on the end of the block, which forces it upon the commutator, not only feeds it down as it wears away, but

presses it with a firm contact against the flat surface on the holder, thus causing it to run steadily and at the same time have a low electrical resistance. The tension on these brush holders is almost instantly adjusted, and their adoption on machines of the C. & C. Company's make is almost universal.

At the further end of the machine shop is a paint shop and a pattern shop—the company makes all its own patterns.

Toward the railway track is the forge shop where are made the tools of

Ring Armature for Multipolar Dynamo.

East End of Machine Shop. C. & C. Electric Company.

the machine shop and also such forgings as are used in the manufacture of the machines. Beyond that is the stock room and shipping department, which of course abuts the railway siding. In it will be found a stock of all the smaller motors and dynamos that the C. & C. Company manufactures, together with resistances, starting-boxes and the like. The shipments are conveniently facilitated by means of an inclined plane and an ingenious electric hoist, the bases raising the weights to the level of the car sills. In a large wing which is adjacent to the main machine shop is the testing room and winding department, while in another is the stock room for raw material. For the protection of its customers the C. & C. Company carries in stock parts of every machine it has manufactured. In this age of advance and improvements designs are continually changing with all energetic and enterprising companies, but in spite of this fact this company carries an ample supply of parts of its obsolete types to supply any repair orders which may come in.

The various types of machines that the C. & C. Company produces together with its methods of manufacture, possess great interest. Its product consists of multipolar slow speed generators, bipolar machines and small motors for fans, dental work and jeweller's lathes. The design of its multipolar machine has been recently changed. Instead of using the single coil type, the company uses one which involves a bobbin for every pole-piece and therefore all the poles are salient; the magnet is lighter and the leakage is much less. The armature is practically the same as before. It is of the ring type and wound with rectangular wire, so that the winding is extremely dense and compact. The commutator is ample and has a large number of bars, thereby minimizing all troubles of sparking. The field bobbins are very ingenious. They have a special head of cast iron which is of a ribbed structure largely increasing the radiating surface. In addition to that the bobbin is purposely made quite large for the pole-piece and the rotation of the armature sends a continuous current of air between the coil and the pole-piece. By this means the amount of copper used in the field magnet is very much reduced. This type of multipolar machine is made from the largest sizes down.

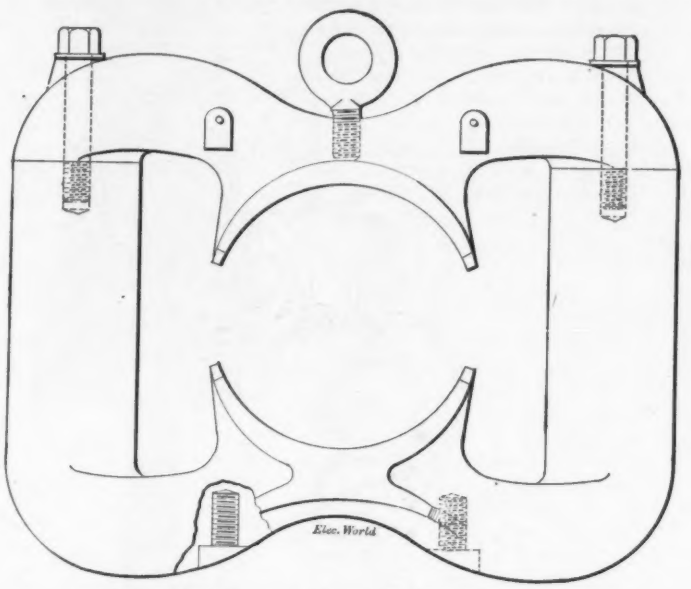
The bipolar machines were the C. & C.'s most successful product some years ago and they are even now such universal favorites that their manufacture is continued. The type of the field magnet of these machines is well known—curved magnet limbs, cast iron pole-pieces and sub-bases. The armatures of these machines are surface drum wound and their performance has been so satisfactory that the company sees no reason for modifying their design. It has been a little mystifying to many designers why the C. & C. Company continues to use the curved magnet limbs in preference to straight ones or how it can produce such a difficult winding at a competitive price. The advantage of the curved form is obvious. Its shorter magnetic circuit and its conformation to the curve of the lines of force render its reluctance extremely low. The magnet spool is wound in a machine and the winders have become so expert that there is really little difference in the time consumed in winding between this curved form and the straight spool. The cores of these curved waists are of steel with thin steel collars cast on the end to secure the winding in place. The shunt winding is put on first and on top of that the series winding, which always consists of a number of small wires wound in multiple. The spool is then covered with a rope-wound finish which makes it quite attractive. The armatures are very carefully wound and every section is securely insulated from its adjacent sections by a specially prepared paper. The insulation is tested by an induction coil. The bearings of the machine, as in all of the C. & C. machines, are self-oiling and aligning, and seldom overheat. In this they are pioneers in a practice that has been universally copied.

Of late years the company has been experimenting largely with steel in its magnet construction. Passing through all the difficulties which other manufacturers have encountered in attacking this problem, the company has at last succeeded in securing steel of a composition which is uniform and with regulating properties which are satisfactory. It is therefore producing a new type of steel magnet with cores and a divided magnetic circuit, having but one joint, the total number of magnetic joints being two. The machine is extremely light and readily wound. The company finishes the magnets and their faces in large quantities on a big planer, and are, therefore, enabled to produce good work at competitive prices. In fact, the company's aim has been to simplify its methods in manufacture with this end in view.

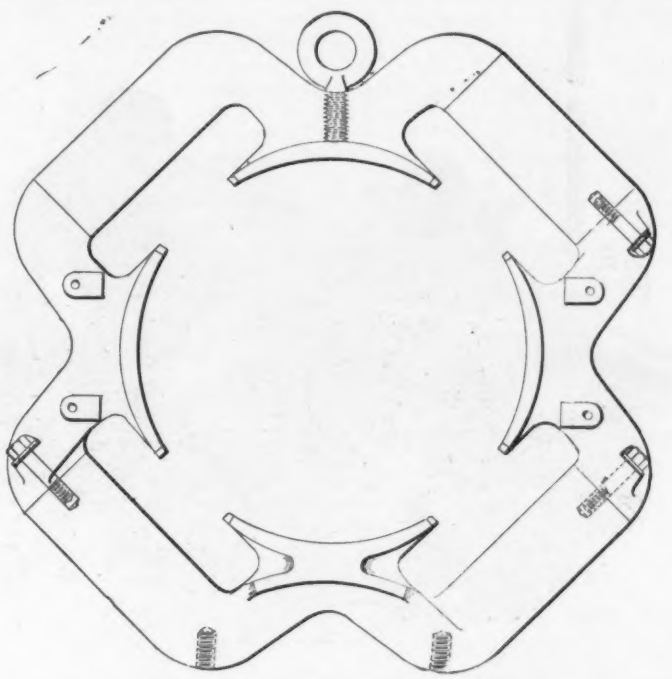
Main Machine Shop. C. & C. Electric Company.

Together with the Manchester type of steel machine the company has also produced a four-pole machine, which is simply an extended conse-

quent pole type, and possesses the same desirable qualities of lightness. Another interesting machine is the printing press motor. This motor is of the single-coil divided magnetic circuit type. The armature is of the ring construction and is embraced both on the inside and outside by the magnetizing pole-piece. It is, of course, multipolar, and consequently revolves at a very slow speed. It is compact and of the exact shape suitable for printing press work. The smaller motors for fan work and similar purposes are quite interesting. They are of the upright bipolar type and have a ring armature. This ring armature consists of semi-circular laminations, which are pivoted at one end, allowing the ring to be broken and swing on that pivot. They are thoroughly insulated and the bobbins



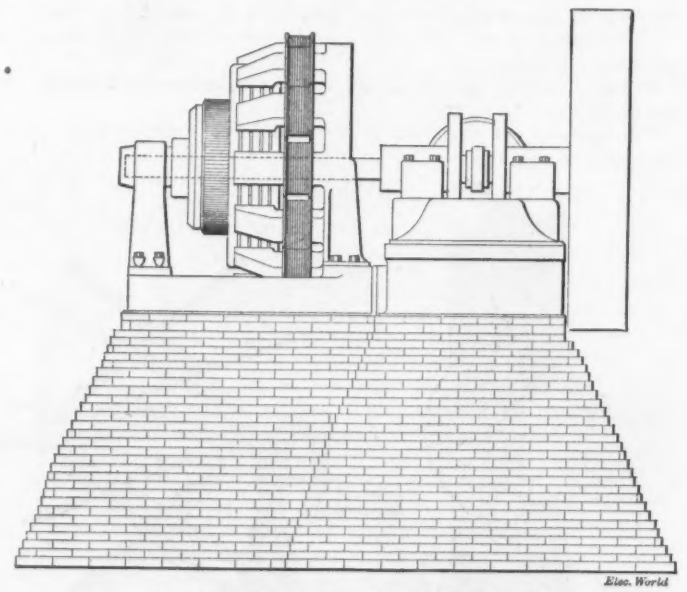
FIELD FRAME OF C. & C. BI-POLAR MACHINE.



FIELD FRAME OF C. & C. MULTIPOLAR MACHINE.

are slipped on, the ring closed and riveted together and mounted on a clamp spider. All of the armature bobbins are wound on a straight former at once, 15 at a time. The completed armature is provided with an iron balancing ring, which is normally secured to the shaft. The necessary balancing weights are fastened to this ring.

The testing room of the C. & C. works is adjacent to the main machine shop and is completely equipped for giving the machines a most thorough trial. The floor is suitably divided into sections which are specially provided for testing machines which may be placed on them. Wires for carrying away the output and other pressure wires for voltmeter circuits are provided for every section. The machines are loaded with banks of



C. & C. DIRECT-CONNECTED GENERATOR.

lamps and other suitable resistance or are tested by electrical methods, one machine as a motor driving another as a dynamo. A complete record is kept of every machine that leaves the works; its performance in the testing room and its cost of manufacture.

In addition to the ordinary commercial instruments for testing dynamo machines there are provided galvanometers of the most delicate D'Arsonval type with appropriate resistance boxes, and many other laboratory instruments for the most accurate measurements.

The various types of dynamos and motors can be adapted to almost any purpose, by suitably winding them. The C. & C. Company has taken advantage of this fact and produces motors for elevators which are cumulative wound, shunt motors for ordinary motor purposes, differential motors for constant speed, arc motors for use on constant current circuits, and in fact motors for any voltage that is practical for direct currents.

The company makes all its dies and punches, all its armature discs, thereby maintaining them standard. The armature discs are subjected to a rusting process rather than insulating them with paper, and the company states that by this means it obtains 30 megohms insulation between the discs. This high resistance is of course not necessary, but is an example of the thoroughness of the construction of the C. & C. machines.

The company is well provided with all tools that are needed in dynamo manufacture. It has a grinding and buffing department, baking ovens for electrical windings and many special facilities for winding the machines. Besides dynamo machines the company supplies a number of accessories, some of which are very ingenious. Prominent among these is a motor starting-box, which is attractive in appearance as well as efficient in operation. It consists of a slab of slate or marble upon which is mounted a double pole switch for opening and closing the motor circuit, and also a rheostatic control which is made automatic by means of magnets, the whole resistance being thrown in if the line falls or if the motor becomes overloaded. The terminals are of the clamp type and will normally hold any size of wire. The resistance is of iron wire strung back and forth on an appropriate frame, and is well ventilated.

The Fashioning of a Lamp.

The Bryan-Marsh Company, New York, in designing its new catalogue, has departed from the usual conventional methods of preparing such matter for the trade. Its new catalogue just issued opens up with a very entertaining story entitled "The Fashioning of a Lamp," written by Maurice Hyde Cleveland. The story is a very interesting one, and with the aid of several excellent half-tone illustrations the reader is given an insight into the delicate and interesting processes involved in the manufacture of incandescent lamps. Following the story comes a well-illustrated catalogue of Bryan-Marsh lamps of all sizes and designs.

Track Drill.

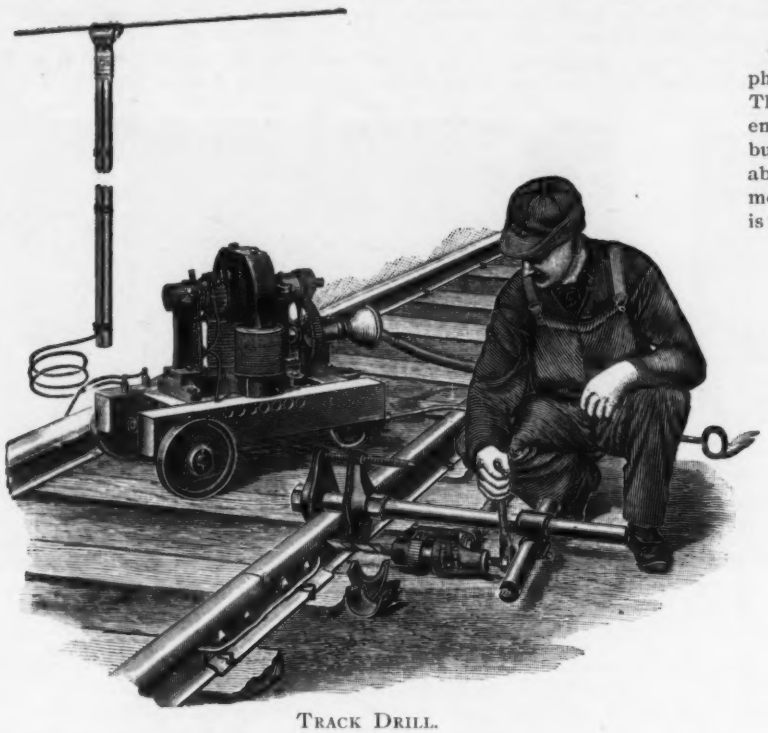
The use of any other power than electric in electric street railway construction and operation in these days seems rather anomalous. Where the power is present on the overhead line there is no good reason why all repairing and other work cannot be done by the application of electric power.

This idea has been carried out by the Stow Manufacturing Company, Binghamton, N. Y., in the electric track drill shown in the accompanying illustration, which represents a combination of an electric motor with a Stow flexible shaft.

This machine is meeting with much favor among electric street railways on account of its convenience and flexibility of application.

The track drill press was especially designed for this particular service. The gears are covered to avoid exposure to grit and dirt, and they are geared as 5½ to 1. This machine will drill holes up to one inch in

diameter. The motor is of the company's standard make, and is wound for 500 volts. With the track-drilling outfit comes a pole 13 feet long with a hook connection at one end. By hooking the pole on to the trolley



Track Drill.

wire the power is brought down to the motor. The motor is set on a truck to facilitate moving about as the work progresses, and the outfit is in every way thoroughly practical.

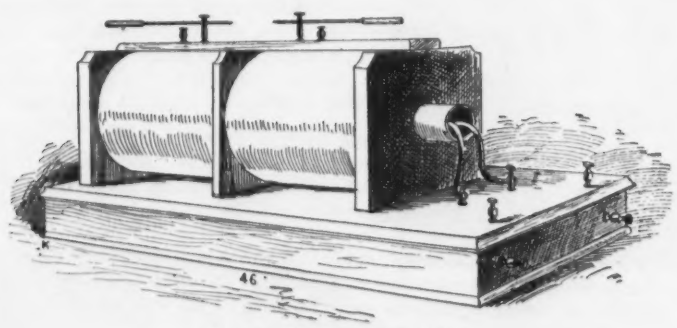
Large Induction Coil.

On Friday last a private view was given at the factory of the International Electric Company, 76 Beekman Street, New York, of a large induction coil just finished by that company for a prominent physician in Brooklyn. This coil is to be used for Röntgen ray work in connection with surgery. Its construction embodies some interesting features. Some of its dimensional figures will no doubt be of general interest.

The primary coil, which is removable, consists of 25 pounds of No. 5 copper wire, wound 306 times around a core made up of No. 18 soft iron wires. The secondary coil is divided into half-sections, with a total of 100 pounds of No. 36 copper wire, representing a length of 1,314,400 feet, or a little more than 250 miles. Each half-section is subdivided into four smaller sections for the purpose of avoiding too high potential between any two of them. The secondary coil is easily removable from the base, and the sections are so made that they can be turned on their axes to give easy access to the terminal posts.

The condenser, which is contained in the base, has a surface of 500 square feet.

The two half-section coils give a 6-inch spark each, both together giving a 12-inch spark. The voltage at the terminals is estimated to be about 1,000,000. The vibrator is separate from the coil, and on the same base is a commutator for changing the direction of the current. The vibrations can be made slow or rapid by the adjustment of a weight along the armature extension arm.



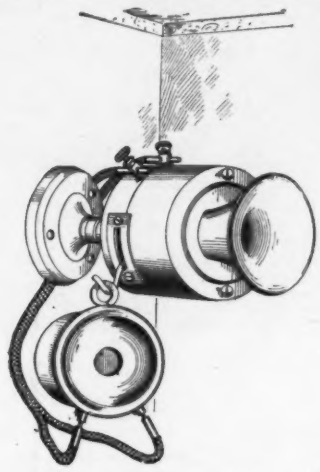
Large Ruhmkorff Coil.

The coil complete weighs 400 pounds, is splendidly finished and encased in a hard-rubber shell, the end-pieces being solid blocks of the same material, one inch in thickness. The base is highly polished mahogany. The current to operate this coil will be supplied by a Crocker-Wheeler dynamo of special design.

The exterior dimensions of the instrument are: Length of base, 42 inches; width, 24 inches; depth, 9 inches; coil, diameter, 13½ inches; length, 30¾ inches.

Telephone.

The G. & T. telephones are made by Gay & Thwaites, Philadelphia, Pa., in three styles, which are designated No. 1, No. 2 and No. 3. The transmitters on each of these sets are exactly alike, the only difference being in the mounting. No. 1 is a desk instrument without bell or button, these being placed on or near the desk. No. 2 is a wall set suitable for factories, stables, warerooms, etc. The bell and button are mounted on this instrument, making a very compact arrangement. No. 3 is a house set, and is so constructed that it can be readily attached to any



Interior Telephone.

call bell or annunciator system for communication between different rooms and kitchen or from room to room.

The transmitter is of the granular carbon variety and owing to peculiar construction will not pack.

The firm also fits magneto bells to its telephones when the distance is too great for battery signals.

Measuring Machine and Winder.

This apparatus (Fig. 1), which is made by J. Jones & Son, New York, is designed for the rapid and accurate measuring of wire, tape, ribbon, cord, etc.

The dial pointers are adjustable and easily reset, and are held in place by friction. The machine accurately registers up to 10,000 feet, and its dimensions are, height, 12 inches; dial, 3½ x 2¼ inches.

The frame is of cast iron, japan finish, and the dial is of white enamel with black letters.

The guide rollers are adjustable to accommodate any diameter, from the smallest to the largest.

The machine was designed to be used in conjunction with the wire winder (Fig. 2) which was recently put upon the market by this firm.

The winder is so constructed as to allow the opening or closing of the arms by movement of the collar on the shaft. This collar

Fig. 1.

Fig. 2.

being set at any desired point by a thumb-screw, a coil of any diameter within the range of the machine can be wound. The winder is made of cast iron, japanned in black, and is strong and serviceable.

These two instruments make a handy combination for retail dealers and others having to wind coils.

Steel Insulating Pin.

The accompany illustration represents a steel insulating pin, manufactured by Fred. M. Locke, Victor, N. Y. The pin is constructed of a locust wood thimble, mounted upon a steel bolt, which passes from the top of the pin through a half-inch hole in the cross arm and is securely fastened on the under side of the latter by a nut and metal washer. The thimble serves as a brace to resist the strain or pull on the pin and at the same time covers the pin hole in the cross arm, thus, it is claimed, by keeping out water and moisture, preserving the arm. The pins are adapted to all classes of line work, and being made of an all locust wood top the cost is considerably lessened. An indestructible insulator pin is constructed on somewhat similar lines, but adapted for use on iron arms and fittings. It is galvanized and can be readily attached on iron pole fittings, and when in place is neither cumbersome nor inconvenient, as is often the case with such fixtures.

STEEL INSULATING PIN.

American Street Railway Association Convention.

Mr. T. C. Penington, secretary of the American Street Railway Association, has sent out a circular to the supply men in relation to the next convention which will be held in St. Louis, on May 20 next, continuing four days. The building in which the meetings are to be held is the one erected for the Republican National Convention, and is 260 x 180 feet. One hundred and eighty feet square of this space will be partitioned off for exhibits of apparatus and supplies. Exhibits of like character will be grouped together, and space will be assigned in the order of application. Wires carrying current will be brought into the building from street railway circuit, the voltage being 550 so that all mechanical devices may be operated. The Executive Committee of the Association has fixed the price at 10 cents per square foot, and ruled that no space of less than 100 square feet will be assigned, but applicants may have as many multiples of this quantity as they may wish, all in one body. Payment for space should be made to Mr. T. C. Penington, secretary and treasurer of the American Street Railway Association, 2020 State Street, Chicago, Ill., on or before Oct. 1, 1896. Application for space should be made to Mr. George W. Baumhoff, Chairman Committee on Exhibits, Park and Vandeventer Avenues, St. Louis, Mo. Space must be applied for by Aug. 15. Watchmen will be in charge of the premises so that exhibits will be safe.

Worcester Polytechnic Institute.

The twenty-sixth annual catalogue (for 1896), of the Worcester Polytechnic Institute, Worcester, Mass., contains no less than 156 pages, and the plans of instruction and details of the courses of study are very complete. Course V. constitutes the electrical engineering course. In this course the aim is to impart such instruction and to afford such practical training as will prepare a young man to enter intelligently upon actual work in connection with electrical industries, and will at the same time supply him with a secure foundation for a professional career.

The equipment of instruments and apparatus for the production and measurement of electrical currents is full and adequate.

The register of students is complete, and the names are classified under different headings.

Lachine Rapids Power.

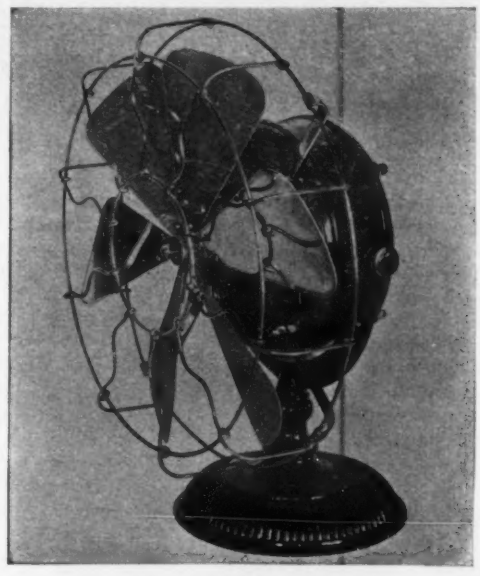
The Lachine Rapids of the St. Lawrence are at last to be utilized. For some time past work has been carried on by the Lachine Rapids Hydraulic Company, upon a large wing dam which runs out for more than 1000 feet into the St. Lawrence River. A fall of water is secured by means of this dam, sufficient to develop at the low-water season 15,000 horse-power. This water-power is to be transformed into electricity.

Upon the dam a power-house will be built which will run its entire length and show an unbroken interior 1000 feet long. The basement of this will be occupied by the water-wheels from the Stilwell-Bierce & Smith-Vaile works, at Dayton, O. The main floor will contain the dynamos, of which there will be 12, each of 1000 horse-power, or 12,000 horse power in all. They will be of the General Electric Company's latest multiphase type, and will generate current for transmission to Montreal for use there in lighting the city, operating the street railways and in any and all other lighting and power purposes.

Apart from the fact that this plant will exceed in interest any yet installed, the contract for this electrical installation is the largest ever placed at one time for electric dynamos. It is also worthy of note that, although it was competed for by every prominent electrical manufacturer in the world, the superiority of the American apparatus kept the order with home manufacturers.

Alternating-Current Fan Motor.

The '96 model alternating-current fan motor of the General Electric Company embodies many improvements, the most important of which is perhaps the universality of direction which can be given to the draft caused by the revolving blades; the motor-field frame being provided with trunnions resting on a yoke, the current of air may be directed at almost any angle in a vertical plane. The yoke is so set in the base that the motor may be moved through a complete circle horizontally and the current be directed toward any point, as desired. The yoke may also be removed from the base and inserted in a wall bracket. The design of the motor is both simple and ingenious. The field is a ring built up of thin iron punchings, with inwardly projecting teeth carrying the field wiring. The armature is a cylinder of iron laminations, with small, bare copper rods running through the iron and terminating in copper discs fastened at the end of the core.



ALTERNATING-CURRENT FAN MOTOR.

There are neither brushes nor commutators; in fact, this small fan motor embodies principles similar to those involved in the large General Electric induction motors.

To reduce the friction of the starting and running current the fan is provided with smooth-running bearings with hardened steel cones and balls. No oil is required to lubricate this bearing.

The fan motors herewith illustrated are wound for either 104 or 52 volts, and for frequencies of either 60 or 125 cycles.

The complete device is artistic in design, well proportioned and handsomely finished, the fan and guard being nickeled and the motor, yoke and base black japanned. The diameter of the fan is 12 inches and the speed 1800 revolutions per minute.

The 35-Mile Three-Phase Transmission at Fresno, Cal.

The work on the three-phase transmission of electrical energy to Fresno, Cal., which has been carried on for the past year, is rapidly drawing to completion. This transmission will be the longest and most unique in many ways ever effected commercially, and will result in endowing Fresno and the surrounding towns and villages with a system of light and supply of cheap power equal to that of any eastern city situated in proximity to a coal centre.

The power-house is located on the North Fork of the San Joaquin River, in Madeira County about 35 miles northeast of Fresno, at the foot of a steep hill and facing one equally as steep.

The point of diversion lies some miles away, where the North Fork runs through a narrow canyon with solid rock walls. A flume and ditch with a total length of seven miles have been built and excavated on the easy side hill slopes, and the right of way has been cleared of all trees and obstructions for a width of 150 feet. The grade of the canal and flume is 5.28 feet to the mile. The lower bank of the canal is sufficiently wide to serve as a wagon road for the inspection teams. The minimum

low water flow of the stream at the point of diversion is 50 cubic feet per second, which will develop, at the head available, over 7000 horse-power at the water-wheels.

The intake is located at a natural dam and the headgates and canal are cut in the solid rock. So rapidly does the river fall at this point that the canal 300 feet from the headgate is 30 feet above high water mark. This frees it from all danger from freshets. The entire system of headwork and canal is below frost line and thus is not subject to effects of snow or cold.

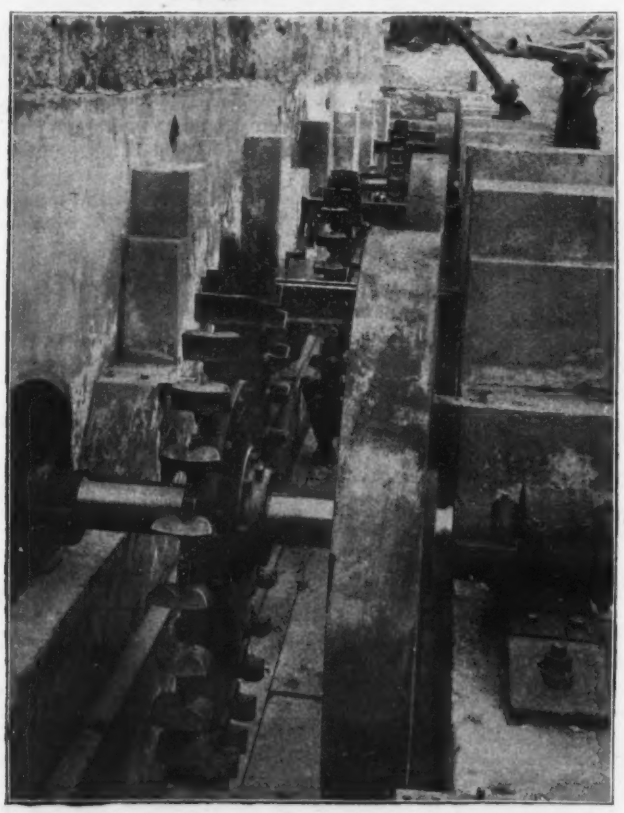
At the end of the canal is a natural basin which covers several acres

Site of Reservoir.

and has a dyke of rock extending about three quarters of the distance around its circumference. With an expenditure of less than $3000 an embankment has been constructed for the remaining distance and a reservoir formed, which at a maximum depth of water of only 10 feet will hold sufficient water to operate the plant at full load for several days consecutively. By means of this provision it is also possible to shut off the ditch for repairs or change.

The reservoir is situated at the top of a high hill, the river being some 1600 feet below. The pipe line leading from the pressure box in the reservoir is 4100 feet long, and in this distance the vertical difference in level is not less than 1400 feet—one of the highest heads of water ever used for power purposes. For the first 400 feet the pipe is of steel, riveted. For the balance of the distance it is of lap-welded pipe with lock joints, five eighths of an inch thick at the lower end with a diameter of 22 inches.

At the power-house the pipe enters a receiver of three-quarter-inch steel, 57 feet long and 30 feet in diameter. The joints are of the butt strap



Pelton Wheels Outside the Power House.

type, and the receiver is designed to stand a working pressure of 800 pounds per square inch.

The power-house is of native granite, is 75 feet long and 30 feet wide, with a wooden roof. The water-wheels are outside the main power-house, the shafts passing through the heavy granite wall, which effectually keeps all water and moisture out of the dynamo room. The three wheels are of Pelton make, 57 inches in diameter, each capable of developing 500 horse-power at 600 revolutions per minute under an effective head of 1410 feet. They have steel-plate centres and bronze buckets, and are fitted with fly-wheels five feet in diameter. Separate wheels are provided for the exciters.

The electrical installation is not yet completed. It will consist of three

Flume Crossing the North Fork.

General Electric Company's three-phase generators each of 350-kw capacity, directly connected to the water-wheel shafts. The current will be raised in transformers to 12,000 volts and will be carried on a pole for 34.4 miles to the substation at Fresno. It will then be transformed down to 200, 1000 and 3000 volts, the first for the low-tension supply in the business portion of the city; the second for the three-phase supply in the residence districts; the third for the three-phase supply to the vineyards and wineries within a radius of 10 miles from the substation.

Contiguous to the station is the pump house of the Fresno Water Company in which the pumps are already operated by a 75-hp, three-phase

View of Pipe Line and Pole Line.

induction motor. This is the first motor operated by the transmitted current.

The completion of the work is being rapidly pushed forward. Within a few weeks it will be finished and another great step forward in the electrical transmission field will have been made.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, May 23, 1896.

GENERAL ELECTRIC showed greater strength, and the trading in common was more active. The highest quotation reached during the week was 36½, closing at 35¾. There was a net gain of two points on the week's transactions. The total number of shares that changed hands during the week was 10,935.

TELEGRAPHS.—Trading in Western Union was rather small, but prices showed increased firmness, closing at a net gain of 1⅛, as compared with last week. Postal Telegraph was slightly firmer, closing at a ½ point above last week's closing.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	97	99
" " " Brooklyn	100	100	102½
" " " Boston	100	135	140
" " " Philadelphia	100	137	..
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	34½	34⅞
Electric Storage, pref	100	36	37
General Electric	100	35¾	35⅞
General Electric, pref	100	73	75
Westinghouse Consolidated, com	50	..	29½
" " pref	50	..	53

BONDS.

Edison Electric Ill., New York	105	103	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	206	..

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	205½	206½
American District Telegraph	100	38	40
American Telegraph & Cable	100	92	95
Central & South American Telegraph	100	124	127
Commercial Cables	100	150	..
Erie Telephone	100	60	61
New England Telephone	100	..	90
Postal Telegraph-Cable	100	87	88
Western Union Telegraph	100	85¾	86

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	18⅛	18⅜
Brooklyn Rapid Transit		24⅝	24¾
Brooklyn Traction	100	..	14
" " pref	100	46	48
Buffalo St. Ry	100	70	73
Cleveland Electric Ry	100	..	..
Columbus St. Ry	100	44	47
Hestonville	100	55¼	55⅛
" pref		..	62½
New Orleans Traction	100	11	14
" " pref	100	57	60
North Shore Traction	100	29	31
" " pref	100	79	81
Rochester St. Ry	..	20	25
Steinway Ry	..	45	50
Union Railway (Huckleberry)		98	105
Union Traction, rcts $10 pd	..	14⅛	14¾
West End, Boston	100	71½	72¼
" " pref	100	..	92
Worcester Traction	100	15½	17
" " pref	100	87	90

BONDS.

Brooklyn Rapid Transit 5s. 1945	100	78	
Buffalo St. Ry. 1st con. 5s	100	106	..
Cleveland Elec. Ry. 1st mtge 5s	100	100	103
*Columbus St. Ry. 1st 5s	100	95	100
Rochester St. Ry. 1st 5s	100	99½	102
Union Railway (Huckleberry) 1st mtge 5s		102½	105
*Westchester Electric 1st mtge 5s	100	100	102

* With accrued interest.

TRACTIONS.—Street railway securities have been stagnant during the past week, and the prices have continued to sag. There was practically no business. The Brooklyn securities were dull and weak, as a result, it is supposed, of the continued agitation regarding the speed of cars, and the injunction against the occupation of the Plaza by car tracks.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, May 25, 1896.

W. R OSTRANDER & CO. have moved from 204 Fulton Street to 22 Dey Street.

SPECIAL MEETING.—A special meeting of the Westinghouse Electric & Manufacturing Company will be held in New York on June 4.

THE HUNT CONVEYOR now in operation and on exhibition at the Exposition, will be removed at the close of the exhibition period to form part of the apparatus being installed by the C. W. Hunt Company, New York, in the Municipal electric light plant, Rodney and Ainslie Streets, Brooklyn, N. Y.

HENRY G. ISSERTEL, E. E., of the New York office of the Walker Company, Cleveland, O., has been appointed by the faculty of the National College of Electro-Therapeutics, Indianapolis, Ind., to fill the chair of practical dynamic electricity. Mr. Issertel's friends are glad to congratulate him upon this honorable recognition.

THE BROOKLYN BRIDGE TRUSTEES on May 20 authorized the expenditure of $100,000 for increasing the electrical equipment of the bridge. They also authorize the reception of bids for a new power-house. The trustees have decided to install an electric plant and not receive power from outside sources. This, they say, will result in a saving of $55,000 yearly.

THE "SCIENTIFIC AMERICAN" offers a premium of $250 for the best essay on "The Progress of Invention During the Past Fifty Years," the paper not to exceed in length 2500 words. The papers submitted will be referred to a select jury of three for adjudication, and the successful prize-winner will be published in the *Scientific American's* fiftieth anniversary number on July 25, next.

MR. D. H. LEDBETTER, manager of the Cordelle, Ga., Telephone Company, has been attending the Electrical Exposition, and expresses himself as highly pleased with the show. The Cordelle Telephone Company, under Mr. Ledbetter's management, has 150 telephones of the American Electric Telephone Company, and has just completed a line to Fitzgerald, Ga. He will probably, during his visit North, place an order for the telephones for this line.

THE PHOTOGRAPH OF THE N. E. L. A. DELEGATES.—The photograph of delegates and others attending the Electric Light Convention, which appeared in a recent issue of THE ELECTRICAL WORLD, was greatly admired and many secured copies to take away with them. For the information of those who desire copies we would say that the photograph was taken by Prince, the well-known photographer, of 31 Union Square, New York, and copies can be secured from him at $2.50 each.

VALUE OF AN AUTOMATIC FIRE ALARM.—One day last week fire was discovered in one of the coal bunkers of the United States warship *Indiana* which lay at her dock in the Brooklyn Navy Yard. The alarm was given by the automatic fire-alarm with which the ship is equipped, and the promptness with which it was given undoubtedly saved the vessel from destruction. The alarm system used on the *Indiana* is that of the Electric Heat Alarm Company, Boston. Other warships equipped with this company's system are the *Brooklyn* and *New York*, and the *Iowa* will be fitted up with it.

AMERICAN ELECTRICAL APPLIANCES FOR ENGLAND.—The Electrical Company, Limited, 122-124 Charing Cross road, London, England, one of the large concerns of that city and a branch of the Allgemeine Elektricitäts Gesellschaft, of Berlin, has determined to open an American department for the purpose of introducing into the United Kingdom the best American products in the electrical line. That company has entrusted the buying in this country to the Chapin-Douglas Electric Company, 136 Liberty Street, to whom price lists and discounts for this trade should be addressed. Exclusive rights for the sale in the United Kingdom of such goods as are purchased will be the plan of operations. Mr. F. T. Eggers, the managing director of the Electrical Company, Limited, sailed in the steamer *New York* on Wednesday, May 27. Mr. Eggers has been in this country several weeks, and states that his company is in a position to handle all kinds of electrical specialties of merit, and undertake the financing of patents in England. All communications should be addressed to the Chapin-Douglas Electric Company.

PHILADELPHIA NOTES.

Branch Office of THE ELECTRICAL WORLD,
927 Chestnut Street,
PHILADELPHIA, Pa., May 22, 1896.

MR. CHAS. WIRT, of 1028 Filbert Street, manufacturer of the Chas. Wirt brush, announces that Mr. D. Charmers, of 114 Liberty Street, New York City, has a full stock of his brushes.

MR. JULES VIENNOT, the well-known special advertising agent, has moved his office from 504 Walnut Street into larger and more commodious quarters at 524 Walnut Street, where he will, as in the past, extend a hearty welcome to his many friends.

GAY & THWAITES, 1111 Arch Street, have recently installed 60 sets of their No. 3 telephones in the Rittenhouse apartments, and also 12 sets No. 1 desk

telephones in the Vulcanite Building, 1710 Market Street. The demand for these telephones they report, has been so great that they devote their time almost exclusively to their construction and installation.

THE AMERICAN SILK MANUFACTURING COMPANY will send, on application, a neat little folder on the merits of their raw silk machinery-wipers. It contains some valuable pointers on that useful article for mills, and gives testimonials from authentic concerns. The silk machine-wipers of the American Silk Company have found their way into many of the leading mills and electrical plants, and wherever a satisfactory test has been given them have, we are informed, been generally adopted. They are washable and non-combustible.

THE TECHNIC ELECTRICAL WORKS report that their facilities for manufacturing have been greatly increased by the extension of their shops, the addition of new machinery and tools. They now have an interchangeable system of manufacture, permitting of a ready duplication of all parts requiring renewal. A special feature is being made of carrying in stock a large quantity of all sizes, enabling prompt fulfillment of orders Several railway boards, and boards for lighting plants, especially of the panel type, are among the orders now on hand. They are also making a specialty of their standard single-contact switch for which they report a large demand.

THE PENNSYLVANIA HEAT, LIGHT & POWER COMPANY has accepted the offer of the Electric Trust to sell its preferred and common stock, and thereby obtains control of nearly all the principal electric-lighting plants in the city. The terms are $130 per share for 5000 shares of preferred stock, and $10 per share for 31,440 shares of common stock, or a total of $1,907,600. The stockholders of the Electric Trust will all be at once notified of the terms which have been offered, and may accept or decline to sell their holdings as may to them seem best. There is, however, a large proportion of the stock held by parties who have already consented to the terms, which ensures the carrying out of the programme. The stock will be placed in the hands of trustees on the 15th day of June, at which time 25 per cent. will be paid in cash, the party transferring it receiving an obligation of the Pennsylvania Heat, Light & Power Company for the remaining 75 per cent., which will mature in three installments of 25 per cent. each, the last payment maturing in the early part of 1897. This obligation will draw interest at the rate of 5 per cent., dating from May 15. When 50 per cent. of the purchase price has been paid the trustees will transfer the stock to the purchaser. The money for this purchase will be raised by assessment on the preferred shares of the Heat, Light & Power Company. The parties were represented at the final meeting by J. Lowber Welsh for the Electric Trust, and by Martin Malony and William L. Elkins, for the Pennsylvania Heat, Light & Power Company, together with counsel, Charles Morgan, representing the trust, and George S. Graham and Samuel B. Huey the Heat, Light & Power Company. The representatives of the latter company made two or three propositions which were not entertained by the Trust, whose original proposal was then accepted. Through this deal the Pennsylvania Heat, Light & Power Company secures control of the principal electric lighting companies of the city. The territory covered by the trust extends over the entire central portion of the city. The companies it controls have city contracts for lighting 2,449 arc light for street lighting, for which the city pays about $500,000 a year. The Pennsylvania Heat, Light & Power Company has, independent of the others, valuable franchises in the central section of the city. It purchased the Edison Electric Light Company in January, and is said to have begun negotiations for the more extensive of the independent electric light companies which have franchises outside of the territory covered by the Trust.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., May 22, 1896.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—This institution has issued a circular giving the requirements for the degree of Master of Science.

THE WASHBURN-MOEN MANUFACTURING COMPANY, Worcester, Mass , has just received from the Chicago West Park Commission contract for about 65 miles "Crown" lead-covered underground cable for electric lighting.

MR. GEO. T. MANSON, of the Okonite Company, was a welcome visitor to Boston this week. There are few men in the electrical business who enjoy more extended popularity than Mr. Manson. His intimate contact with the business dates with the early commercial applications, and no one in it possesses a larger circle of friends or business clientelle.

THE BERNSTEIN ELECTRIC COMPANY has removed its business offices and factory to the large brick building at 355 Congress Street, South Boston, thus concentrating in one building its lamp manufactures and business office. The well-known and deservedly popular "Bernstein" lamps have as great a hold as ever with the electrical public. In fact, its business shows a constant increase, and the wisdom of this movement of concentration will be made manifest, particularly through a more prompt fulfillment of orders, which will be greatly appreciated by the trade, the accommodation of which Mr. Henry B. Cram, treasurer and general manager, has eagerly sought and which fact has made for him a wide and enviably creditable reputation.

WESTERN NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, Ill., May 22, 1896.

MR. WILLIAM B. CLEVELAND, manager of the Forest City Electric Company, Cleveland, O , is paying a visit to Chicago for a few days. He reports business with them most satisfactory for this season of the year.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has succeeded in producing, with a few slight changes from the regular Upton arc lamp, a lamp that will burn 30 hours with a single pair of carbons. This lamp is meeting with much favor.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, O., reports a very encouraging increase in its business as compared with last year at this time. During April it closed several important deals with electric light and electric railway companies for generators of different capacities.

THE HAYES-TRACEY-FYFE COMPANY, manufacturers of automatic motor rheostats, has moved to 225 West Twelfth Street, Chicago Its business has made such strides during the past few months that it has become necessary to increase its equipment and move into larger quarters.

THE CINCINNATI MUSICAL FESTIVAL has attracted considerable attention all over the country, and it may be interesting to our readers to know that the Triumph Electric Company furnished two electric motors to drive the 80-inch fans which ventilated the hall, 70,000 cubic feet of air being supplied by each fan per minute.

A UNIQUE SOUVENIR.—The Wagner Electric Manufacturing Company, St. Louis, has gotten up a very handsome and serviceable souvenir in the shape of an ink stand, in form representing one of the Wagner company's transformers. The case is made of bronze, and on the face a frame is provided for the insertion of a small monthly calender. The top of the transformer is hinged and serves as a cover to the ink-well. The miniature transformer stands on a white marble base, and the appearance of the article is extremely handsome.

THE STANDARD UNDERGROUND CABLE COMPANY announces that it has completed arrangements whereby it is enabled to undertake the installation of underground systems of all descriptions, complete in every detail The company is now ready to furnish and install the conduits as well as the cables and will furnish quotations for the equipment of underground systems with cement-lined pipe, vitrified clay or wooden pump log conduit, as may seem best under the circumstances, as well as for systems complete in every detail; conduits, manholes, handholes, cables, junction boxes, terminals, etc. The company has established a conduit department with Mr. F. S. Viele at its head as manager. Mr. Viele is an experienced practical engineer in conduit and cable construction.

General News.

NEW INCORPORATIONS.

THE DECORAH ELECTRIC COMPANY, Decorah, Ia., has been organized by W. N. Stewart, Thomas Von Rolf, S. V. Potter, George W. Adams and F. J. Rosenthal.

THE WAYNE COUNTY TELEPHONE COMPANY has been incorporated at Fairfield, Ill., by Edwin E. Crebs, C. M. Brock and D. P. Moore, with a capital stock of $25,000.

THE CENTRAL ELECTRIC MANUFACTURING COMPANY, Tacoma, Wash , has been incorporated with a capital stock of $50,000, by E. E. Salisbury, A. F. Dean and others.

THE HELENA WATER & ELECTRIC POWER COMPANY has been incorporated at Helena, Mont., by S. T. Hauser, T. A. Marlow and Barton Sewell. Capital stock, $200,000.

THE NATIONAL ELECTRIC BRAKE COMPANY has been incorporated at Chicago, Ill., with a capital stock of $100,000. The incorporators are Moses L. Rothschild, George A. Damon and Lorenzo E. Dow.

THE FAIRMOUNT CONSTRUCTION COMPANY, Philadelphia, Pa., has been organized with a capital stock of $50,000, by Lindley P. Bane, Charles L. King, Philadelphia, Pa., and Edwin J. Dewey, Haddonfield, N. J.

THE AMERICAN ELECTRIC COLD SUPPLY COMPANY has been formed at Kittery, Me., with a capital stock of $1,500,000. Those interested are Mark W. Paul, Kittery, and Alfred B Nettleton, of Washington.

THE BOSTON MONTAUK FIRE ALARM COMPANY has been incorporated at Portland, Me., by John D. Gould, Brooklyn; Charles A. Hanson, East Orange, and Edwin W. Brown, Boston, Mass. Capital stock, $300,000.

THE MONTPELIER STREET & SUBURBAN RAILWAY COMPANY has been organized at Montpelier, Ind., with a capital stock of $10,000. The incorporators are F. C. Brownell, Charles Pape, O. E Evans, J. H. Shoemaker and E. C. Palmer.

THE BAY STATE ELECTRIC HEATING COMPANY, Saco, Me., has been organized with a capital stock of $150,000. The incorporators are Louis P. Hager, Waltham, Mass; John McCloskey, Boston, Mass., and William O. Tuttle, Newtonville, Mass.

THE UNIVERSAL SURFACE ELECTRIC RAILWAY COMPANY, New York, N. Y., has been incorporated in West Virginia by William Lawrence, Julius Hirshfield and Leopold Bruckheimer, New York City. Capital stock, maximum, $2,500,000; minimum, $1,250.

TELEGRAPH AND TELEPHONE.

BRYAN, O.—Bryan is to have a telephone exchange.

FAYETTE, O.—Fayette is to have a telephone exchange.

SMITHLAND, IOWA.—This place will soon have a telephone exchange.

CHARLEVOIX, MICH.—The entire telephone system of this place is to be rebuilt

WINONA, MINN.—The telephone line between here and Rochester has been completed.

NORTH LUBEC, ME.—A telephone line between North Lubec and Eastport is talked of.

PRAIRIE CITY, IA.—The telephone toll line between this place and Monroe is nearly completed.

OGDEN, UTAH.—The Telephone Company has put in a metallic circuit from Ogden to Logan.

NEW HAMPTON, IOWA.—The Northwestern Telephone Company will put in an exchange here.

CLEVELAND, O.—The Home Telephone Company has increased its capital stock from $50,000 to $500,000.

VISALIA, CAL.—Work on the new Springville-Porterville-Visalia telephone line will soon be commenced.

KANSAS CITY, MO.—The long-distance telephone line between this city and Omaha has been tested and works satisfactorily.

CAMPELLSVILLE, KY.—A new telephone company has been organized at Campbellsville, which will build a direct line to Lebanon.

PETERSBURG, VA.—A movement is on foot looking to the establishment of a telephone line between Petersburg and Dinwiddie Courthouse

PARIS ILL.—There is a probability of Paris having telephone connection with Redmon, Dudley, Brocton, and Cherry Point in the near future.

CHAGRIN FALLS, O.—Dibble & Stafford have been granted a franchise and will connect by telephone all the towns of Geauga County with this place.

DES MOINES, IA.—The Postal Telegraph Company has received permission to lay underground its wires for a distance of 800 feet from its office in this city.

GREENUP, KY.—A telephone company has been organized to connect the towns of Grayson, Leon and Olive Hill in Cater County with Martinsburg in Elliott County.

ELECTRIC LIGHT AND POWER.

CLAYTON, ILL.—The talk of introducing electric lights in this place has again been revived.

BLANCHESTER, O.—The citizens have voted in favor of issuing $30,000 water and light bonds.

STUART, IA.—A change is to be made at the electric light plant whereby its capacity will be doubled.

CANANDAIGUA, N. Y.—Mr. Mungeris is again presenting his plans for electric lighting to the village fathers.

WHITE HAVEN, PA.—The electric light plant at White Haven was recently destroyed by fire. Loss, $20,000.

CANNON FALLS, MINN.—A franchise has been granted to the Cannon Falls Electric Company to light this place.

ST. LOUIS, MO.—The St. Louis Electric Light & Power Company has increased its capital stock from $7500 to $200,000.

PAWTUCKET, R. I.—The City Council of Pawtucket unanimously voted $100,000 for a municipal electric lighting plant.

BOWLING GREEN, MO.—Noah and William Ledford, of St. Louis, have bought the Bowling Green electric light plant.

MADISON, WIS.—This city will construct an electric lighting plant, paying $5000 down and $1000 a month until it is paid for.

MILLVILLE, N. J.—An electric light plant is to be established in this place and bids for the same will be received up to June 5.

MARYVILLE, MO.—The Maryville Electric Light & Power Company has let the contract for building its new plant in this city.

NIAGARA FALLS, N. Y.—The Buffalo & Niagara Falls Electric Light & Power Company has notified its customers that on June 1 next the rates for electric lighting will be increased. The charges for incandescent light service in lots of 12 or more lamps will be 40 cents a month, and in lots of 11 or less it will be 45 cents a month; metre rates have been correspondingly increased, This is a jump from 30 cents per month caused by a competition with the Niagara Falls Hydraulic Power Manufacturing Company. At the last-named rate it is claimed that the companies were losing money.

MUNICIPAL LIGHTING IN ST. JOSEPH.—The citizens of St. Joseph, Mich., were led to believe that a municipal electric light plant was a necessity, and the Council was on the point of calling a special election to vote on the subject, when Mr. W. Worth Bean, president and general manager of the St. Joseph & Benton Harbor Electric Railway & Light Company, published a statement in the local paper, which had the effect of dampening the ardor of the municipal control enthusiasts. Mr. Bean presented some telling facts and figures bearing on the subject, and the result was that the Board of Public Works in Benton Harbor declared against municipal ownership, and in St. Joseph the proposed election was not called.

MT. PLEASANT, MICH.—A company has been formed for the purpose of manufacturing, lighting and milling purposes. The company which proposes this enterprise is the Pleasant Creek Power Association, and its object is to put in an electric power plant at the mouth of Pleasant Creek Canyon, the plant to furnish power and light for manufacturing and other purposes in Mt. Pleasant, Moroni and Fairview cities. Those whose names appear in connection with the scheme are C. W. Anderson, Niels P. Nielson, D. C. Jensen, all representative business men of this city. This enterprise will give electric competition in this city, as a plant is already in existence, but the main idea of the new company is to furnish such good power as to encourage the establishment of factories here.

THE ELECTRIC RAILWAY.

BRADFORD, PA.—The work of constructing the Bradford street railway has been commenced.

WILKINSBURG, PA.—The Braddock Electric Railway Company is trying to secure right of way through this place.

EGYPT, PA.—The Lehigh Valley Traction Company will, it is said, in the near future build a branch road to Egypt.

MILFORD, MASS.—After much delay the Milford, Holliston & Framingham street railway system has been put in operation.

WETHERSFIELD, CONN.—A meeting was held to consider the proposition of the street railway company to extend its lines.

WILMINGTON, N. C.—Philadelphia capitalists are prospecting with a view to building a railway from Wilmington and Southport.

PORTLAND, ME.—The Portland & Deering Street Railway Company will extend its tracks to Pride's Bridge, a distance of about 1½ miles.

CHATTANOOGA, TENN.—It is proposed to extend the Chattanooga & Northside Electric road to Walden's Ridge. T. J. Nichol is secretary.

HARRISBURG, PA.—The Harrisburg & Mechanicsburg Electric Railway Company will extend its tracks from Third and Bridge Streets to Rosemont.

LONDON, ONT., CAN.—The street railway company will be permitted to build a line from their Wollington Street track, along Regent Street to the pit.

PITTSBURG, PA.—The Pittsburg, Allegheny & Manchester Traction Company is fitting out its cars with a new quick-acting brake. The claim is made that the cars can be stopped much quicker than at present.

WAPAKONETA, O.—Frank Hunter and Hugh Mathers, of Sidney, are interested in the project of constructing an electric railway between that place and Wapakoneta, by way of Minster, New Bremen and St Marys.

HOOSICK FALLS, VT.—The Board of Highway Commissioners has granted the application of the Hoosick Railway Company to extend its lines to the Vermont State line from the present terminus at Walloomsac.

ELIZABETH, N. J.—The City Council will meet, when the Plainfield Trolley Company will ask for a franchise to build a road in Westfield Avenue to Netherwood, to connect there with the line already established.

PEORIA, ILL.—The Glen Oak & Prospect Heights Railway Company has made application to the Board of Trustees of North Peoria, for the purpose of obtaining permission to construct an electric railway in that place.

GREEN BAY, WIS.—The contract for doing the grading for the Fox River Street Railway Company's extension of their line from Green Bay to Depere has been secured by W. B. Anderson. Work will be commenced at once.

UNIONTOWN, PA.—The Uniontown Electric Railway Company will extend its line through Leith and Hopwood to Brownfield, a distance of three miles. The extension together with the extra cars necessary will cost about $20,000.

NIAGARA FALLS, N. Y.—The main line of the Niagara Falls & Suspension Bridge Street Railway Company will hereafter be run by power from the station of the Niagara Falls Power Company, instead of that generated by the railway company.

NEW YORK.—Chief Engineer Martin, of the Brooklyn Bridge, has submitted to the Board of Trustees his disapproval of the proposition to run elevated railway trains over the bridge. It is stated that the matter will be dropped for the present.

BROOKLYN, N. Y.—A new speed ordinance has been introduced into the City Council. It provides for a fine of $100 for each conviction. Under the present law, motormen are not liable to arrest for driving their cars faster than the regulation speed.

BROOKLYN, N. Y.—Twenty cases of violation of the trolley speed ordinance by the Brooklyn Heights, Brooklyn City & Newtown and Nassau Railway Companies have been reported by the police trolley inspectors. Summons and complaints have been served upon the companies, and the suits will come up for trial about the first day of June.

TUCKAHOE, N. Y.—The Highway Commissioner has signed the franchise of the North Mount Vernon Trolley Company for the right of way through the town of East Chester. The company has the franchise for Scarsdale, and only requires that of White Plains to complete its proposed line. The road must be in operation before next January.

ASBURY PARK, N. J.—The Atlantic Coast Electric Railway Company has finally overcome all obstacles which prevented the extensions of its lines along the New Jersey Coast, and the road is now in operation all the way from Pleasure Bay to Belmar, passing through Long Branch, West End, Elberon, Darlington, Asbury Park and Ocean Grove. The line will be extended further south to Bay Head.

BALTIMORE, MD.—At a meeting of the City Council an ordinance was introduced authorizing the Metropolitan Railway Company to lay tracks and operate street cars to be propelled by a system of underground electricity. The ordinance grants the right of way on certain streets, and also gives the privilege to any other street railway company to use portions of the Metropolitan Company's proposed tracks.

THE UTICA BELT LINE RAILWAY.—The quarterly report of the Utica Belt Line Street Railway Company, ending March, 1896, filed with the Board of Railroad Commissioners, shows gross earnings from operation of $38,650.66; operating expenses, $24,866.45; net earnings from operation, $13,784.21, which after deducting the interest, taxes on the property, taxes on the earnings, and rentals, leaves a net income of $2929.61.

FLUSHING, L. I., N. Y.—A committee of the Flushing Village Association including President John W. Weed, M. J. Quirk and W. T. James, recently held a conference with President R. T. McCabe and Superintendent Chambers, of the Steinway Railway Company, with regard to the extension of the tracks of the Flushing & College Point Electric Railway to the Flushing cemetery, and that section of the village known as Hitchcock's Park.

WHITE PLAINS, N. Y.—Papers were filed in the County Clerk's office at White Plains, by which the New York, Elmsford & White Plains Railway system was extended to the City of Mount Vernon by the post road and from Mount Vernon to the City of Yonkers by McLean Avenue and South Broadway to Getty Square. The present Central Avenue line was extended so as to met the extension between Mount Vernon and Yonkers, making a belt line between the three places.

PRESIDENT GEORGE WESTINGHOUSE, JR., says the use of electricity on the branch of the Pennsylvania Railroad from Burlington to Mount Holly in New Jersey, has been attended with highly successful results, but that it is too early to discuss its adoption on the main line of the road. The Westinghouse Company has perfected an electric system, which it is convinced will

work satisfactorily on elevated railways. An experimental line has been in operation at the works in Pittsburg.

PITTSBURG, PA.—The Allegheny Traction Company proposes to change the route of its main line, the intention being to extend the line to Glenshaw, *via* the Evergreen extension, and abandon the tracks between Millvale and Etna. The reason for the proposed change is that owing to the country through which the former route passed being hilly, there was little chance to build, consequently there was little passenger traffic. The new route covers a growing section, and will soon be a well-paying district.

BROOKLYN, N. Y.—A petition was received by the officials of the Nassau Electric Railway Company from residents of Bensonhurst asking that the fare on the Bensonhurst line be raised to 10 cents instead of five. The privacy and quiet of the village have, it is said, been greatly disturbed by crowds of city visitors, curiosity seekers and idlers on Sundays since the fares were reduced. The company is pledged not to raise the fare, and so Bensonhurst will have to wait until the curiosity of the outside world is appeased.

BROOKLYN, N. Y.—Judge Clement, in the Supreme Court of this city, announced that the Brooklyn Bridge Plaza was not to be given away by the bridge trustees to any railroad or corporation whatever. He maintained that as it was purchased with public money for the specific purpose of keeping a clear approach to the bridge, no other legal disposition could be made of it. This decision was given on a motion to continue a temporary injunction restraining the Brooklyn Bridge trustees from permitting the Brooklyn Heights Railway Company to lay tracks in the plaza and through Liberty Street, in payment for which the company was to give an annual rental of $2,000.

PITTSBURG, PA.—City Solicitor Rogers has been instructed to carry to the Supreme Court the cases of the city against the Pittsburg & Manchester Traction Company for $140,000 and $40,000 against the Pleasant Valley Company. These suits have been pending for four years and were entered at the time the City Auditor was investigating the Comptroller's office. The lower courts have decided against the city. The claims of the latter are based on the fact that when the Pleasant Valley and Manchester Companies made a reorganization of their stock accounts, the Pleasant Valley's was increased about $1,000,000, and the Manchester's nearly $3,000,000. The city wants to collect 5 per cent. on these increases.

Personal Note.

MR. P. WARNFORD-DAVIS, managing director of the Endolithic Ivory Company, of London, England, is in the United States, introducing to the attention of electrical companies, contracting engineers, etc., in America the ivory name-plates of which his company has made so marked a success in Europe. The Endolithic Ivory Company has a secret process for printing the name in black on the white ivory or bone background in such a way as to be absolutely permanent. The extensive business done by the company on the other side of the Atlantic warrants the belief that there is also a large field for the work here.

Trade and Industrial Notes.

WARREN WEBSTER & CO., Camden, N. J., in a pamphlet just issued, set forth the advantages of the Webster vacuum system of steam heating. The system is well illustrated.

I. T. E. CIRCUIT-BREAKER.—An artistically designed and executed catalogue of the I. T. E. automatic magnetic circuit-breaker is being placed in the trade by the Cutter Electrical & Manufacturing Company, Philadelphia. The instrument is excellently illustrated in detail and perspective.

CONTRACTS AWARDED.—The Brooklyn Bridge trustees have awarded a contract to the Babcock & Wilcox Boiler Company for two boilers of 400 horse-power each. The Walker Company, Cleveland, O., received the contract for two generators, and the Southworth Foundry & Machine Company for two 600-hp engines. A contract was awarded to the Pullman Palace Car Company for 20 cars, to be equipped with electric motors.

THE GARLOCK PACKING COMPANY, Palmyra, N. Y., reports that the extensive addition to its factories is now nearly completed. It is now manufacturing waterproof hydraulic and high-pressure piston packings in both ring and spiral forms. The company is receiving for both of these packings a constantly increasing trade, and is crowded with orders for all kinds of its various packings at both the Palmyra, N. Y., and Rome, Ga., factories.

LARGE BUSINESS IN MOTORS.—The diversity of uses to which electric motors are now being put is forcibly exemplified by a glance at the orders which the power and mining department of the General Electric Company received during the first two weeks of last month. The motors were called for to operate printing presses, saws and planers in a box factory, an assortment of mining machinery in a coal mine, machinery in a large bakery, blowers in a stove works, a Gould fire pump, a mine pump, large Brush arc lighting dynamos, a jib crane, traveling cranes, machinery in an oil cloth works, inclined railway, etc., etc.

THE AMERICAN WELDLESS STEEL TUBE COMPANY, Toledo, O., requires a 100-hp tandem-compound engine, Russell type preferred, fitted with one 50-kw multipolar (six pole) direct-connected dynamo, wound for 110 volts, speed of 275 revolutions per minute, same to be connected direct to the engine shaft. Also one marble switchboard, with the following instruments fitted: One ammeter, one voltmeter, one fireproof rheostat, one single-pole double-throw switch, one ground-detector, two fuse-blocks, two switchboard lamps, brackets and shades. The engine foundation will be furnished by the tube company. The contractor must erect engine, connect with boiler, and also wire up switchboard, put in running order, ready to connect the service-wires in the building. The dynamo must be of a type so that incandescent lights, arc lights and power can be run from the same.

OPERATION OF MINES BY ELECTRICITY.—The introduction of electricity into the operation of the mines has resulted in economy so noticeable that an increase in the plant at the Silver Lake Mines, Silverton, Col., is now being made to provide for an extension of the system in the mines and to reinforce the water-power, which is not sufficient to furnish all the power required throughout the year. Two cross-compound Corliss engines, with cylinders 24 x 46 x 48 inches, each engine of 850 indicated horse-power, are now being set up, together with water-tube boilers, mechanical stokers, coal and ash conveyors, feed-water heaters, separators, water meter, coal weighers, the whole making what will be the most thoroughly modern steam plant in the State. The difference between the cost of coal at the power-house and its cost at the mine, which is at greater elevation by some 2500 feet, is such that the saving effected, even when steam power is used for generating purposes, will ensure an ample return on the investment, while the economy induced by the use of the water-power is considerably greater. Mr. Stoiber, therefore, feels that in adopting electricity for the operation of his mines he has more than considerably diminished the cost of working them. The present plant now in operation consists of two 150-kw General Electric three-phase water-driven generators, supplying current to one 100-hp motor for the mill; one 100-hp motor for the air-compressor; one 75-hp motor for the hoist; one 15-hp motor for the pump; one of 1 horse-power for a blower, and to incandescent lights scattered throughout the station, mill and mine. The additional plant will consist of two 150-kw General Electric generators, one 100-hp motor for the mill; one 15-hp motor to drive a pump, and two 10-hp for blowers, forges and miscellaneous machinery. And to eventually utilize to the full the capacity of the steam and water-power plants additional and larger generators will be set up Not the least interesting feature of this installation is that although the entire output of electrical energy is to be used in the operation of a single mining property, it will be when completed the largest electric power plant in the State of Colorado.

Business Notices.

The illustrations in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 15 South Warren Street, Syracuse, N. Y.

"REFRIGERATING MACHINERY," containing the general principles of refrigerating and ice-making machinery, by George Richmond, M. E., mailed free on receipt of 20 cents in stamps. American Engineering Publishing Company, 333 Adams Street, Brooklyn, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MAY 19, 1896.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

560,184. MAGNETIC SEPARATOR; F. J. Barnard, Seattle, Wash. App. filed Sept. 10, 1895. In a magnetic separator, the combination of a sluice, a magnet located over said sluice, a conveyor plate formed of non-magnetic material located under said magnets and over the sluice, and suitable means in connection with the plate for rotating it.

560,193. BLOCK SIGNAL SYSTEM; A. L. Creelman, Chicago, Ill. App. filed Dec. 21, 1894. In a block signal system the combination of a power wire circuit, a signal adapted to be operated by the current therein, an electric light included in the power wire circuit, shunt-circuits around the signal and electric light, a magnetic device arranged to open one and close the other of said shunt-circuits alternately, and an auxiliary circuit adapted to control the magnetic device, and including suitable circuit controllers, adapted to be operated by the passage of a train.

560,212. CIRCUIT FOR LATENT SIGNAL TRANSMITTERS; F. B. Herzog, New York, N. Y. App. filed Feb. 14, 1895. The combination in an electro-magnetically controlled signal transmitting mechanism; of a magnetically controlled locking device, and organizations whereby the latter is not directly affected by the circuit changes accompanying or causing the signal transmission; and mechanism for causing the operation of the locking device to precede the signal transmission.

560,216. ELECTROMAGNETIC DASH POT; J. D. Ihlder, Yonkers, N. Y. App. filed Feb. 8, 1895. The combination with an electric motor and resistance device therefor, of series field magnet coils for the motor connected with said resistance device, a lever arm controlling said resistance device, a disc connected with said arm, and a magnet controlling said disc and inclined in resistance circuit.

560,217. ELECTRIC AUTOMATIC STOP FOR ELEVATORS; J. D. Ihlder, Yonkers, N. Y. App. filed July 27, 1895. The combination with an electric motor and a short circuit therefor, of a switch controlling said circuit, and an automatic stop device controlling said switch.

560,255. HANGER FOR ELECTRIC ARC-LAMPS; T. H. Brady, New Britain, Conn. App. filed Jan. 4, 1896. A hanger for electric arc-lamps, consisting of a pair of dependent hooks, each of which is provided with a hollow base and is composed of electrically conductive material, in combination with a spring, which is made of like material, and is seated within said hollow base, and in electrical contact therewith, extends obliquely across the mouth of the hook, and is provided with a hole, located near the free end of said spring, and fitting over the point of said hook.

560,262. HEAD-BLOCK FOR ARC-LAMPS; A. N. Edeburn, Cleveland, O. App. filed Aug. 12, 1895. In a cut-out, the combination of a shallow metallic plate provided with main and lamp-terminal posts, with a knife-shaped switch-lever pivoted centrally upon the main positive terminal-post, and an intermediate lever pivoted upon the main negative terminal-post provided with a long and short extension, terminal spring-plates upon the lamp-terminal posts, and a slot in the outer extremity of one lever and a pin in the other, whereby the movements of the knife-lever will serve to actuate the other lever.

560,265. ELECTRIC RAILWAY SYSTEM; J. C. Henry, Westfield, N. J. App. filed Nov. 26, 1895. In an electric distribution system for traveling vehicles where the energy is obtained from the several terminals of a three-wire or compensating system, feeders arranged along the line of way, sectional conductors connected to said feeders, and so arranged that one predetermined section is connected with one side of a three-wire system; another section connected with another side of the three-wire system, and a third section that may be connected with either side or in series, with both sides as desired.

560,269. ELECTRIC RAILWAY; N. Leidgen, Milwaukee, Wis. App. filed March 11, 1895. A trolley-wire-supporting device for electric railways comprising a hanger having curved sides for receiving the ends of the wire sections, said sides terminating in upwardly inclined cam-surfaces and weighted eccentrics pivoted to said hanger for clamping the ends of the wire against said curved sides.

560,272. CONNECTION FOR STORAGE BATTERIES. R. McA. Lloyd, New York, N. Y. App. filed Nov. 16, 1895. The combination with a secondary battery element having a projection and with a contact containing mercury, of a copper connector secured to the projection and engaging the mercury and provided with a band of enamel between the projection and mercury contact.

560,275. SWITCHBOARD; D. M. Munro, Gaithersburg, Md. App. filed Feb. 26, 1896. In a switchboard, a series of loop-lines connected to pairs of terminals of subscribers' wires, each loop line comprising a number of pairs of contact points, and bridges for said points, a pair of such points on one loop being arranged in proximity to a pair of such points on another loop, whereby, when said bridges are broken, and said contact-points are connected across from one loop to the other, said loops are brought into a a single circuit.

560,284. ELECTRIC IGNITER FOR GAS LIGHTING; W. F. Rudolph, Philadelphia, Pa App. filed Sept. 6, 1895. An electric igniter for gas lighting, consisting of a fixed electrode projecting over the burner-opening, a movable electrode, a bracket supporting the same, a lever adapted when moved in one direction to axially rotate the movable electrode in the bracket to cause the same to be brought into and out of contact with the fixed electrode a stop-cock with the lever operating said fixed electrode.

560,293. TRAIN SIGNAL; W. Biddle, Brooklyn, N. Y. App. filed March 22, 1894. The combination in an electric signal, of an armature lever, a rolling signal upon the armature lever, two electromagnets for giving motion to the armature lever and to the signal, a circuit closer or wheel operated by the armature lever, and electric circuit connections to the central station or train despatcher's office for indicating the movements of the respective signals automatically.

560,313. POLAR RELAY; T. B. Dixon, Henderson, Ky. App. filed March 27, 1896. In a polar instrument, the combination with a polarized armature movably mounted and main, secondary and tertiary magnet coils each arranged when energized to tend to deflect the armature in one direction or the other, according to the polarity of said coils, of circuit-controlling devices operated by the movement of said armature, and controlling the circuit of said secondary coils, arranged when the armature is in either extreme position to cause said circuit to energize said secondary coils, so as to tend to hold the armature in that position and electrically-controlled circuit-controlling devices, controlled by the circuit of said secondary coils and controlling the circuit of said tertiary coils and arranged when the armature is in either extreme position to cause said circuit to energize said tertiary coils to tend to move the armature to the opposite position.

560,315. ELECTRICALLY ACTUATED DENTAL PLUGGER; J. W. Gilbert, Philadelphia, Pa. App. fled Nov. 7, 1885. The combination of the plugger-handle, the finger actuated circuit-controller slide having guide way connection with the handle, the spring acting on the controller, and the rocking contact adjuster on the plugger handle operated by connection with the controller.

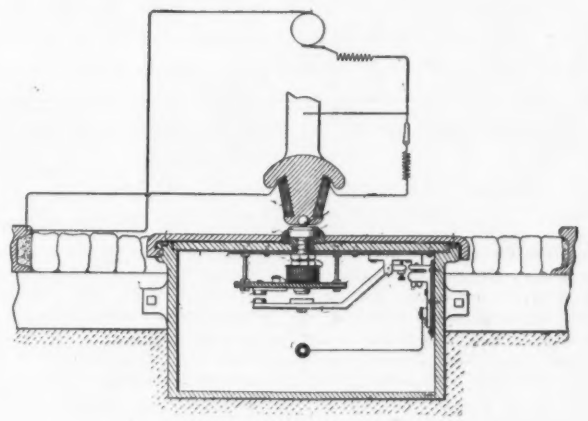
560,328. DYNAMO-ELECTRIC MACHINE; R. Schorch, Darmstadt, Germany. App. filed Dec. 14, 1893. In a dynamo-machine with open-coil-armature winding, the combination of a magnetic field, consisting of two magnet poles or more, each two adjacent ones of which are of opposite polarity, and their pole-surfaces each having such a length that the distance between two poles has doubled the length of a pole-surface, with an armature divided into thrice as many bobbin-spaces as the magnetic field has magnetic poles, and of the windings of these bobbin-spaces, one or more bobbin groups being formed in the manner that the bobbins of each alternate bobbin-space are connected at one of their ends with a ring conductor, so that if a bobbin of such a group is covered entirely by a pole-surface, the two following bobbins of the same group lie outside the next pole-surface, one on each side of it.

560,340. SHUNT CIRCUIT WATER RHEOSTAT; J. Buchel, New Orleans, La. App. filed Dec. 7, 1894. A rheostat comprising a receptacle containing a liquid, the main circuit plates therein, the shunt circuit plates also immersed in the liquid the relative positions of the two sets of plates being adjustable.

560,358. ELECTRICAL ANNUNCIATOR; G. J. King, Oakland, Cal. App. filed Nov. 21, 1895. In an annunciator the combination with electromagnets and their armature, said armature being provided with a detent, of a slide-bar provided at one end with an indicator and further provided with a dog to engage said detent, and means for projecting the slide-bar and it indicator forward when the armature is attracted by the electromagnets, said means consisting of a pivoted lever connected with the slide-bar and provided with an adjustable weight.

560,359. DEVICE FOR RAILWAY SIGNALING OR OTHER PURPOSES; M. B. Leonard, Richmond, Va. App. filed Feb. 5, 1895. In a block signaling system, the combination of a ground-switch; its two contact plates, a locking armature lever by which said switch after having been removed from that plate with which it is normally in contact to the other plate, is when returning to "normal" automatically arrested, and locked in neutral position out of contact with either plate; a spring for drawing said armature into locking position; an unlocking magnet for influencing the armature against the stress of its spring included in an electric circuit, a circuit closer controlling normally open contacts in said circuit, and located adjacent to but electrically independent of the track rails; and actuating means attached to the last or other selected car of a train passing over said track; whereby the passage of the selected car and that car only will operate the circuit-closer to close the circuit of the unlocking magnet.

560,360. ELECTRICAL APPARATUS AND SYSTEM; M. B. Leonard, Richmond, Va. App. filed Feb. 19, 1895. In a block signal system two stations, each equipped with call or signal appliances, and electric connections therefor, and signal-lever locking appliances, an unlocking relay or magnet, circuit connections therefor, and a battery included in said circuit connections in a shunt to the unlocking magnet at the same station, for energizing the unlocking magnet at the other station in such manner that when the circuit is through one battery the unlocking magnet at the same station will be cut out and *vice versa* in combination with a line-wire extending between and terminating in a switch at each station, and two contacts controlled by each of said switches, the electric connections in which the call appliances are included terminate at one end in one of said contacts, and the electric connections, including the unlocking-magnet terminating at one end in the other of said contacts, and one or the other of said circuits being continued through the line-wire according to the position of the switch, and being completed only when both switches are on corresponding contacts



No. 560,551.—ELECTRIC RAILWAY SYSTEM.

560,366. METHOD OF ATTACHING RAIL BONDS TO RAILS OF ELECTRIC RAILWAYS; D. W. Payne, Elmira, N. Y. App. filed Aug. 24, 1895. The method of welding or brazing rail bonds directly to the rails when laid upon a roadbed, which consists in first heating a rail to, or near to, the required temperature at the place of juncture by means of an electrically-heated carbon point applied thereto, and then inserting the end of the bond between rail and carbon point and continuing the application of the electric current until both rail and bond are brought to the required temperature at their place of juncture.

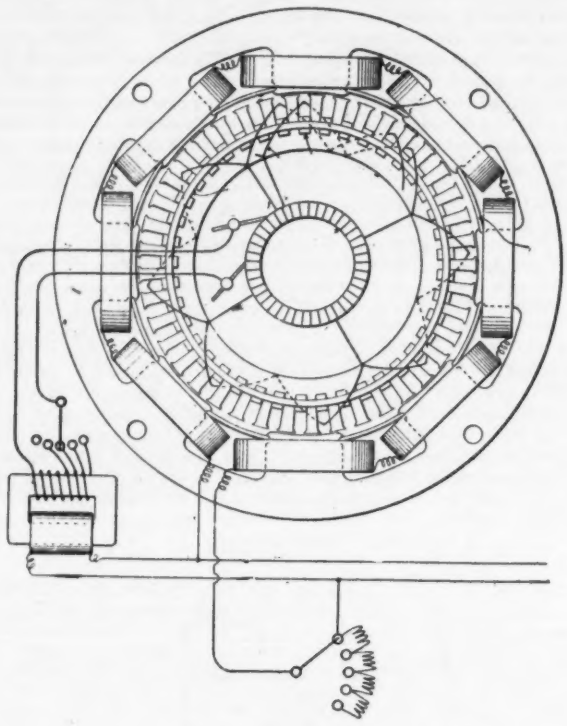
560,370 ELECTRIC IGNITER FOR GAS LIGHTING; W. F. Rudolph, Philadelphia, Pa. App. filed Nov. 29, 1895. An electric igniter for gas-lighting consisting of a fixed electrode in juxtaposition to the burner, a movable electrode having an oscillatory movement and provided with an arm adapted to make and brake contact with the fixed electrode, a box connected with said movable electrode, and a stop-cock in flexible engagement with said box and adapted when actuated to oscillate said movable electrode.

560,375. POWER GEARING FOR ELECTRIC CARS; E. A. Sperry, Cleveland, O. App. filed June 6, 1894. In a motor-car, a motor, the running-gear of the car, power-driving connection from the motor to the running-gear, a yielding coupling forming part of said connection, and a casing enclosing said yielding coupling, said casing being integral with the journal-bearing of the power-driving connection.

560,379. ELECTRIC MEASURING INSTRUMENT; E. Thomson, Swampscott, Mass. App. filed March 29, 1895. In an electric measuring instrument, sets of fixed coils, each set composed of a plurality of coils so arranged that the current traverses the respective coils of each set in relatively opposite directions, and passes through similar coils in the several sets in the same direction; in combination with a movable set of coils also composed of a plurality of coils so wound that the current passes in opposite directions in the respective coils and circuit connections for the different sets of coils.

560,387. ELECTRIC ARC LAMP; E. J. Bagnall, Cleveland, O. App. filed Dec. 14, 1895. The combination with the separating and feeding magnet of an alternating-current arc lamp and the carbons, of an armature-lever connected directly with the armature of said magnet and with the carbons, a retarder and a spring forming the sole connection between said armature lever and the retarder.

560,403 TELEPHONE RECEIVER; S. D. Field, Stockbridge, Mass. App. filed Aug. 24, 1895. The combination in a telephone, of a diaphragm of magnetic material, a core of magnetic material, presented thereto, and two equal reversely-acting windings on the core, one of said windings being nearer the polar extremity of the core than the other, and both being serially connected in the telephone-circuit.



560,591.—Alternating Electric Motor.

560,421. ELECTRIC ARC LAMP; J. McLaughlin, Chicago. Ill. App. filed May 15, 1893. In an electric arc lamp, the combination of a pivoted-armature lever, an electromagnet in main circuit with the arc, a keeper-bar carried by said armature-lever and attracted and held by said main magnet during the operation of the lamp, a mechanical resistance device connected with said pivoted armature-lever, a shunt magnet and an intermediate-pivoted lever between said mechanical-resistance device, and the shunt magnet together with carbon-separating devices connected with the intermediate and releasing lever.

560,427. CIRCUIT-BREAKER; W. B. Potter, Schenectady, N. Y. App. filed Jan. 18, 1896. A circuit-breaker for drawbridges, consisting of a horizontal base-plate, a contact-plate hinged at its forward end and adapted to yield rearwardly in a vertical plane, the outer face of the contact-plate being curved from end to end horizontally, and a spring holding the contact-plate in its forward position.

560,428. ELECTRIC BRAKE; W. B. Potter. Schenectady, N. Y. App. filed Feb. 3, 1896 The combination of a controlling switch arranged to connect a plurality of motors in series or in parallel with and without resistance, and an emergency switch in the controller provided with contacts and connections arranged to open the trolley-circuit, and to close a local circuit through the motors, the local circuit being left open at the controller, by which the controller may be used as power apparatus in one position of the auxiliary switch, but in other positions will combine the motors as generators in steps in series and parallel with and without resistance.

560,451. ELECTRIC BLOCK SIGNAL AND TRAIN LIGHTING SYSTEM; J. C. West, Atlanta, Ga. App. filed Dec. 23, 1893. The combination with a truck of a sleeve fixed thereto, a bored rod movable in said sleeve, means for moving the rod, a second rod having limited movement in the bore of the bored rod, and a trolley connected to the second rod.

560,452. ELECTRIC RAILWAY SYSTEM; G Westinghouse, Jr., Pittsburg, Pa. App. filed July 27, 1895. In a circuit-closing switch for electric railways, an armature and contact-plates and a loosely mounted support therefore provided with downwardly projecting pins or lugs, and a spring in which said pins or lugs rest.

560,455. RAIL BOND FOR ELECTRIC RAILWAYS; H. W. Wyman and F. H. Daniels, Worcester, Mass. App. filed June 26, 1895. As an improved article of manufacture, a rail bond comprising rod or bar, having at each end a terminal made integral therewith, and consisting of a cylindrical portion of larger diameter than the body of the bond, and having an opening or hole of the same diameter therethrough for the reception of a drift-pin or taper-tool and an enlarged end or head forming a flange or projection extending around the cylindrical portion to bear on the rail.

560,471. ELECTRIC RAILWAY SWITCH AND BOX THEREFOR; W. Chapman, Washington, D. C. App. filed July 29, 1895. In a switch box the combination with a bottom comprising a pan and a trough or channel surrounding the same, of a cover or bell having two peripheral flanges at its lower edge, one of which rests in said trough or channel and the other of which extends outside the same.

560,472. CURRENT COLLECTING DEVICE FOR ELECTRIC RAILWAYS; W. Chapman and P. W. Davies, Washington, D. C. App. filed July 29, 1895. In an electrically propelled vehicle, the combination with a collecting bar, of a plurality of pairs of supporting links pivoted to the vehicle truck at their upper ends and having a sliding engagement with the collecting bar at their lower ends.

560,473. ELECTRIC RAILWAY; W. Chapman, Washington, D C. App. filed August, 1895. The combination of a car truck and a contact bar supported thereby, and consisting of a plurality of conducting lengths or sections insulated from each other, with means for cutting either or both sections or the end sections into and out of circuit

560,476. ELECTRIC ARC LAMP; C. L. Coffin, Detroit, Mich. App. filed March 31, 1894. The mode of magnetically affecting an electric arc lamp, consisting in subjecting the arc to the influence of a magnet in which the lines of the field of force are substantially parallel with, and in the same direction as the current producing said arc for the purpose of reducing the counter E. M. F. of the arc.

560,504. SAFETY DEVICE FOR ELECTRIC MOTORS; J. D. Ihlder, Yonkers, N. Y. App. filed Sept. 12, 1892. The combination with an electric motor, of a duplex shunt circuit of relatively high resistance, including two parts of a magnet coil, and a safety device arranged in said duplex shunt circuit.

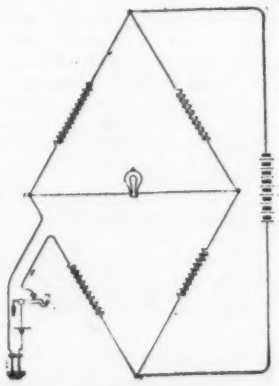
560,506. ELECTRIC BELL; F. & H. F. Keil, New York, N. Y. App. filed Dec. 16, 1895. The combination of an armature with an angular pivoted spring, having a tongue and loop separated at their ends and a bifurcated stud receiving said tongue and loop.

560,551. ELECTRIC RAILWAY SYSTEM; D. MacL. Therrell, Charleston, S. C. App. filed Jan. 9, 1896. In an electric railway system, a series of switch-boxes containing automatic circuit controllers connected with the source of current, which controllers, when actuated to close the circuit by means of a magnet upon the car, operate by the closing of the circuit to repel the actuating magnet upon the car while keeping the circuit closed until after the car has passed.

560,569. ELECTRIC MOTOR FAN; J. D. Brinser, Lancaster, Pa. App. filed July 12, 1894. In a field magnet to be placed within a ring of the revolving armature of a motor for an electric fan, a wrought-iron base comprising two oppositely-disposed pole-pieces and two perpendicularly-placed coil-cores between said pole-pieces; a pole-piece and a coil-core integrally joined at one end, forged in one piece; each core having its diametrically-reduced forward end closely fitted into the orifices in the orifice in the free end of the opposite pole-piece, the cores adapted to have spools with wire coils sleeved thereon, and means provided to hold the pole-pieces in position.

560,588. ELECTRIC RHEOSTAT OR HEATER; H. W. Leonard, East Orange, N. J. App. filed March 20, 1896. A ribbon-like conductor attached to a large mass of material, having a high specific capacity for heat and insulated therefrom by a minimum thickness of insulating material.

560,591. ALTERNATING ELECTRIC MOTOR; R. Lundell, Brooklyn, N. Y. App. filed Feb. 18, 1895. An alternating or pulsating-current electric motor having field magnet coils and a short-circuited armature, with additional armature-coils, having circuit connection with a source of current supply adapted to generate currents of low voltage, the field-magnet coils being connected directly to the current mains. (See Illustration.)



560,617.—Telephone Signal and Signaling Circuit.

560,617. TELEPHONE SIGNAL AND SIGNALING CIRCUIT; A. De Khotinsky, Boston, Mass. App. filed March 13, 1896. The combination of a main telephone circuit, extending between a central station and a sub-station, the telephone switch or circuit changer at the sub-station, and switch connections, and an associated disconnecting-signal at the central station; with a Wheatstone balance or bridge system, the said disconnecting signal being in the bridge or cross-wire, and the telephone sub-station, circuit and circuit changer being connected in one of the resistance arms of the said balance or system. (See Illustration.)

560,619. ELECTRIC SIGNALING APPARATUS AND SYSTEM; M. B. Leonard, Richmond, Va. App. filed Nov. 10, 1894. The combination with a ground switch, its detent arm, and the locking armature therefor, of the locking-magnet for influencing said armature, and an electric circuit, including said magnet and completed through two sets of contacts, the one normally closed and controlled by a track treadle or train-operated device, the other normally open and controlled by the ground switch.